Roseau River HEC-1 Hydrologic Model

prepared for the:
ROSEAU RIVER WATERSHED DISTRICT
P.O. Box 26
Roseau, MN 56751-0026

and the:
U.S. ARMY CORPS OF ENGINEERS
St. Paul District

July 18, 2001

prepared by:
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(Under contract with: Short, Elliot, Hendrickson, Inc.)

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This hydrologic model of the Roseau River Basin was developed for the Roseau River Watershed District for planning purposes, including evaluation of proposed flood control strategies. The model covers the drainage area of the Roseau River to the point where it crosses the International Border and enters Canada near Caribou, Minnesota. The modeled portion is 1,432.2 square miles and consists primarily of cropland, grassland, woodland and wetlands. Although the model is fully functional at this time, it is anticipated that refinements will continue to be made as the planning and implementation process evolves.

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Roseau River HEC-1 Hydrologic Model (July 18, 2001)

Introduction

This hydrologic model of the Roseau River Basin was developed for the Roseau River Watershed District for planning purposes, including evaluation of proposed flood control strategies. The model covers the drainage area of the Roseau River to the point where it crosses the International Border and enters Canada near Caribou, Minnesota. The modeled basin includes 1,009 square miles of drainage area in Minnesota and 423 square miles of drainage area in Manitoba.

The Minnesota portion of the model was developed as part of the Roseau River Watershed District "Overall Plan" revision process as required by the 1998 Red River Basin Mediation Agreement. The Manitoba portion of the model was developed by a Section 22 Study under the U.S. Army Corps of Engineers. The modeling effort of both sides of the border was done concurrently in order to develop a seamless model. This report covers the entire model.

There are significant differences in the type and extent of data available in Manitoba and Minnesota. In general, the Manitoba data has been transformed to provide the necessary modeling parameters in a format consistent with the way data is presented in Minnesota.

Although the model is fully functional at this time, it is anticipated that refinements will continue to be made as the planning and implementation process evolves. Potential users should ensure that they have the latest, or most appropriate, version of the model.

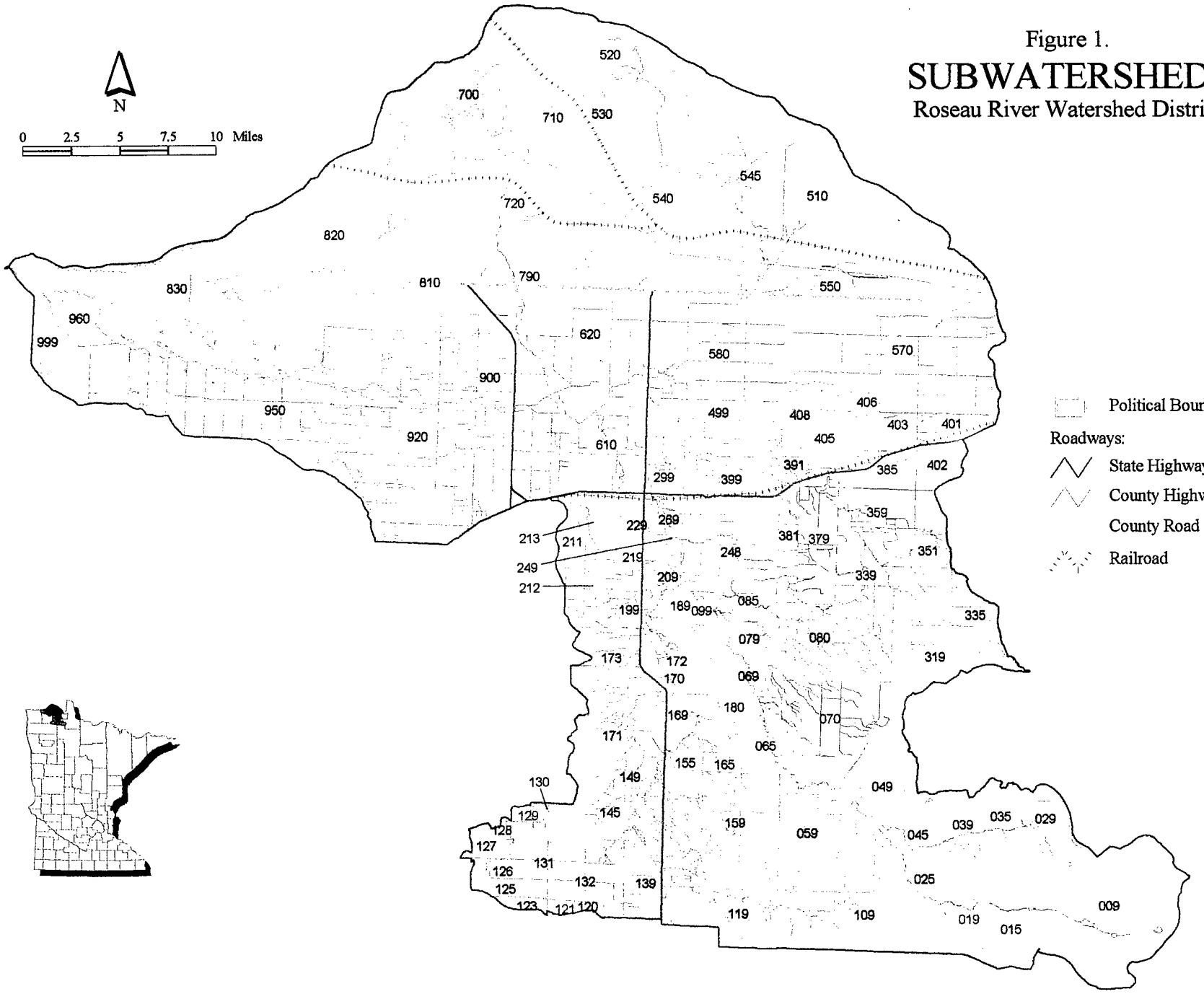
Watershed

The modeled watershed is the upper portion of the Roseau River Basin as outlined on the map shown in Figure 1. The Roseau River is a major tributary of the Red River of the North. It joins the Red River in Canada near Letellier, Manitoba about 91.5 miles downstream from the modeled area. The drainage area of the Roseau River at its mouth is 2,057 square miles. The modeled portion is 1,432.2 square miles. It consists primarily of cropland, grassland, woodland, and wetlands.

Figure 1.

SUBWATERSHEDS

Roseau River Watershed District



JOR Engineering, Inc.

Source: JOR Engineering, Inc. The watershed was subdivided into smaller hydrologic units as shown for modeling purposes based on interpolation of USGS 1:24,000 and Canadian 1:50,000 Quadrangles, and field inspection.

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The Minnesota portion of the drainage area is within the geomorphic areas of the Agassiz Lacustrine Plain. Included are the Inter-Beach area, Beltrami Island area, and Agassiz Peatlands (Minnesota Soil Atlas Miscellaneous Report 173-1980). The Inter-Beach area consists of a linear network of beach ridges and low, poorly drained areas. About half the soils are sandy, 10% are organic, and the rest are loamy. The Beltrami Island area consists of a nearly level to slightly depressional lake plain. Most of the soils are loamy and poorly drained. This region also includes some shallow sands over loamy till, areas of clayey soils, and areas of organic soils. Agassiz Peatlands are a low, very poorly drained lake plain. About 75% consists of organic soils generally from 7 to 8 feet deep. The mineral soils are pre-dominantly sandy and poorly drained.

The Manitoba portion of the Roseau River Watershed tributary to Caribou, Minnesota has been subdivided into Lowland Till Plain, Sandilands Upland, Pine Creek Lowland, and Sprague Creek Lowland (Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin, International Roseau River Engineering Board Report to the International Joint Commission, September, 1975, Appendix A Water Resources).

Sandilands Upland consists primarily of thick sand deposits, overlain along the lower edges by till or lacustrine clays.

Pinecreek Lowlands are mainly peats and lacustrine clays.

Sprague Creek Lowland occupies the eastern portion of the watershed in Manitoba. It is a broad flat area with appreciable local relief developed on glacial till with extensive areas of peat, thick lacustrine clays, and isolated patches of sand.

The portion of the Lowland Till Plain that contributes to the Caribou drainage area is primarily the Menisino Swamp. The swamp is primarily sedge but areas of treed swamp occur at the higher elevations. This area drains into the Roseau River Wildlife Management Area in Minnesota.

Rainfall

Meteorological data used in this model for hypothetical rainstorm events is based on information developed by the (National Weather Service as presented in Technical Papers #40 and 49).

These papers include maps showing expected amounts of point precipitation for storms with durations of 30 minutes to 10 days. The magnitude of storms range from 1 year to100 years and also include an estimate of the Probable Maximum Precipitation (PMP).

Point Rainfall-Duration-Frequency curves were developed from the meteorological data. They are shown graphically in Figure 2. The curves are based on data at the City of Roseau, which is near the geographic center of the modeled watershed. The rainfall intensity tends to increase from northwest to southeast. Therefore, when analyzing individual sub-watershed strategies, it may be advisable to adjust the rainfall amounts.

Area reduction factors are applied by the hydrologic model to reduce the point precipitation to the amount which would be expected to fall over the entire 1,432 square mile watershed area. Smaller storm areas should be used where appropriate to evaluate strategies at a sub-basin level.

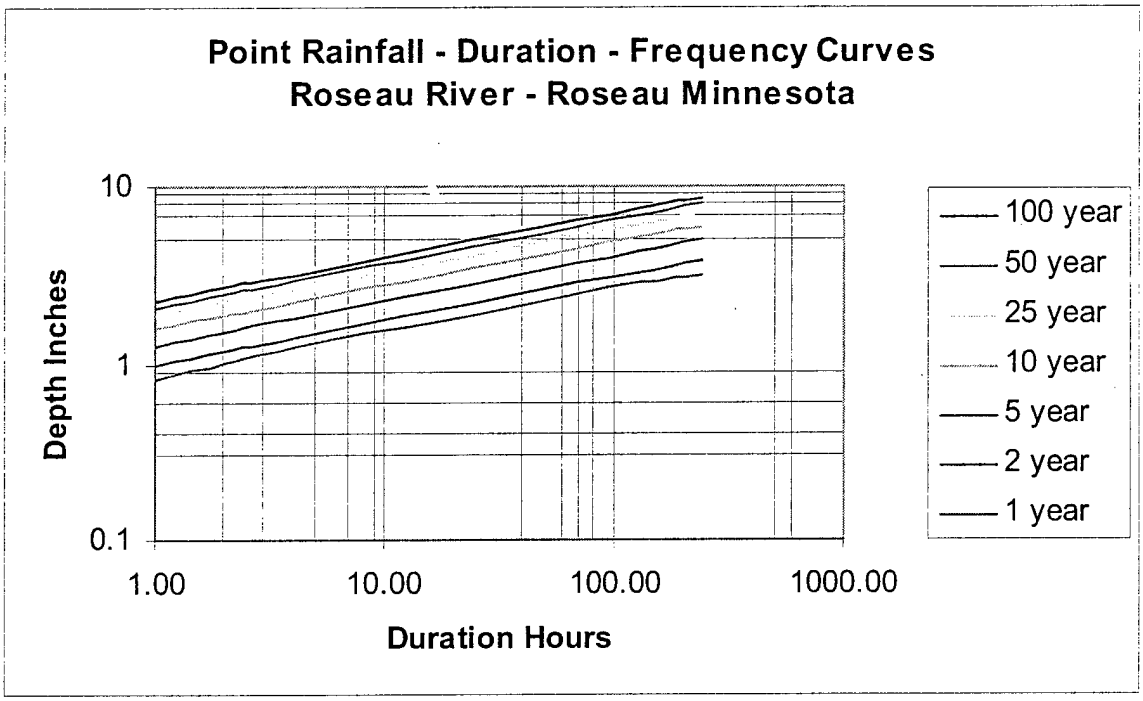
The hypothetical summer storm events that have been analyzed are of 10 days total duration. The precipitation pattern within the 10 days was determined by nesting the shorter duration amounts. In other words, the Maximum precipitation rate of the 6 hour storm is within the 1 day storm which is within the 10 day storm.

Summer Runoff (Rainfall Events)

The amount of runoff generated by rainfall was estimated using the Hydrologic Curve Number (CN) method developed by the Soil Conservation Service (SCS). The curve number takes into account the soil type, topography, land cover, and cultural practices of the watershed, and relates precipitation to runoff. The runoff curve numbers were adjusted for use with10 day duration storms as recommended by the SCS National Engineering Handbook.

SCS curve numbers were developed using Geographic Information System (GIS) based analysis. So far as known, the best available GIS data has been used. The level of detail of the available data varies considerably.

Figure 2


Point Rainfall - Duration - Frequency Curves
Roseau River - Roseau Minnesota
Depth Inches
10
1
0.1
1.00
10.00
100.00
1000.00
Duration Hours
100 year
50 year
25 year
10 year
5 year
2 year
1 year

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The required data layers to determine the curve numbers are land cover and hydrologic soil group. A composite map of the hydrologic soil groups is shown in Figure 3. A composite map of the land use data is shown in Figure 4 and a composite map of hydrologic curve numbers is shown in Figure 5.

The hydrologic soil groups are based on expected rates of infiltration. They are A, B, C, and D, varying from most to least permeable. For some soil types, two classes are given, depending on whether or not the soil has been drained. These were reclassified by processing the data within the GIS system using the assumption that all lands shown as agricultural had been drained.

The land cover data used for Minnesota was developed in the early 1990's by the International Coalition (TIC) and by the Minnesota Department of Natural Resources (MNDNR). The TIC data, which covers most of the basin, was developed from 1990 vintage aerial photography. The land cover for the forested, southeastern portion of the basin, was developed from satellite imagery from 1995-1996 by the Manitoba Remote Sensing Center. MNDNR further reclassified the forested area data set into fewer categories.

The land cover data used for the Manitoba portion was provided by Environment, Manitoba.

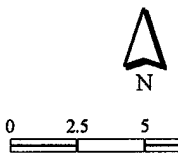
Most of the soils information in Minnesota was from the Minnesota Land Management Information System (MLMIS) 100 meter, generalized soil data. A detailed soil survey of Roseau County has been done by Natural Resource and Conservation Service (NRCS). However, only pre-release detailed soil survey data is currently available from NRCS. Some of the soil survey sheets have been digitized by JOR for the Watershed District. The digitized detailed soils information was used where available.

The GIS soils data for the Canadian portion of the basin was from data developed by the Canadian Department of Agriculture. They do not classify soils into hydrologic groups. The SCS Hydrologic Soils Group was developed based on infiltration rates for each soils class. This was done using criteria described in the (United States Department of Agriculture, Soil Survey Manual, Soil Survey Division Staff, Agriculture Handbook No. 18, Issued October 1993).

Figure 3.

SOIL HYDROLOGY

Roseau River Watershed District



JOR Engineering, Inc.

Source: Soils data was derived through compilation of data from Minnesota Land Management Information System (MLMIS), from the Natural Resource and Conservation Service (NRCS), and the Canadian Department of Agriculture.

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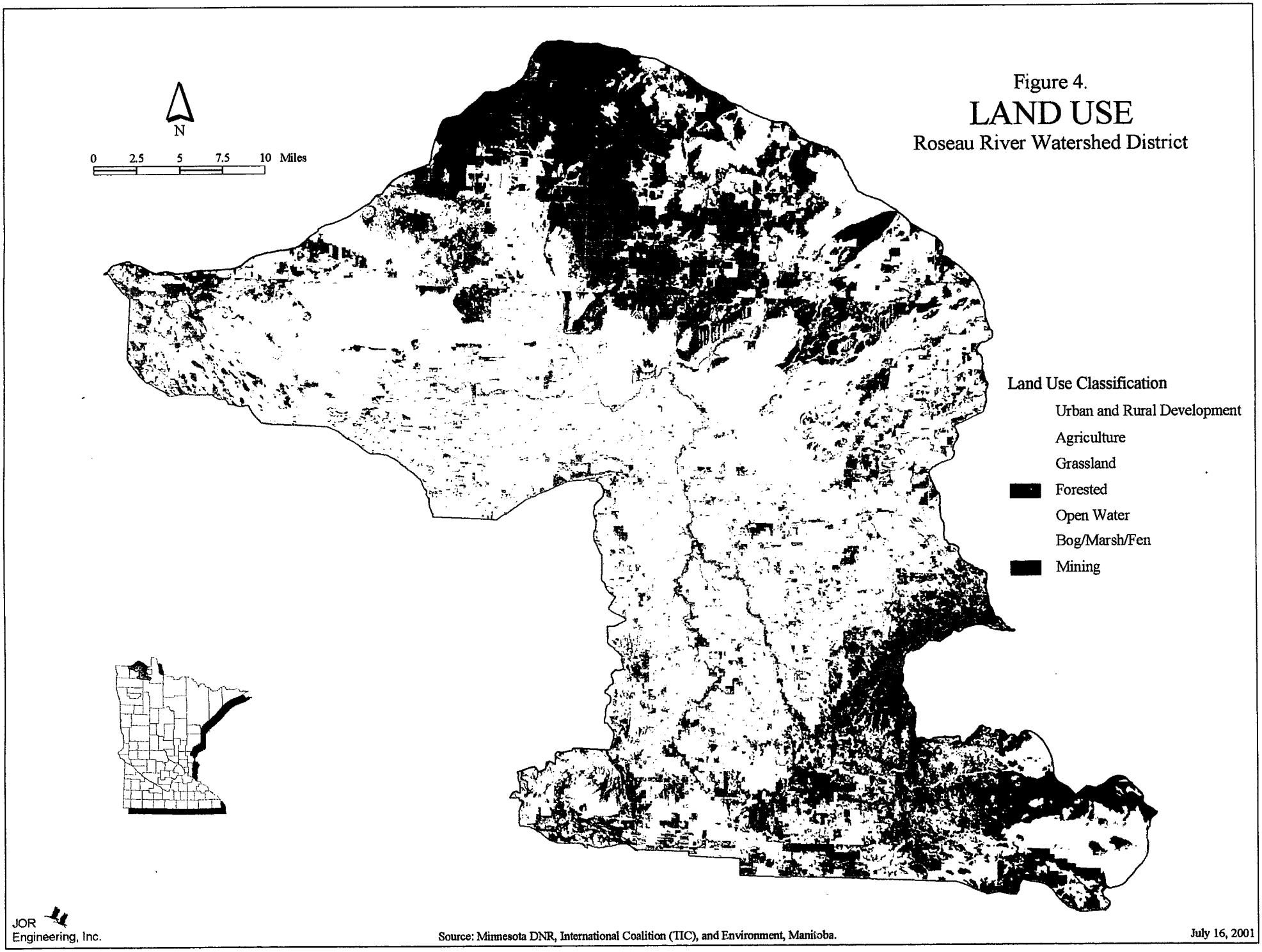
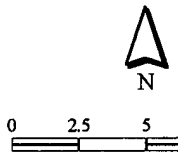

N
0 2.5 5 7.5 10 Miles
Figure 4.
LAND USE
Roseau River Watershed District
Land Use Classification
Urban and Rural Development
Agriculture
Grassland
Forested
Open Water
Bog/Marsh/Fen
Mining
JOR
Engineering, Inc.
Source: Minnesota DNR, International Coalition (TIC), and Environment, Manitoba.
July 16, 2001

Figure 5.

HYDROLOGIC CURVE NUMBERS

Roseau River Watershed District



JOR Engineering, Inc.

Source: JOR Engineering, Inc. The Hydrologic Curve Numbers were created using a method developed by the Soil Conservation Service. The data used to create this dataset was a land-use file (MNDNR, TIC, and Environment, Manitoba), as well as a soils base (MLMIS and NRCS).

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Antecedent Moisture Condition II (normal) was assumed to exist prior to all hypothetical storm events. This is generally considered applicable for moisture conditions when storms would occur in Minnesota. (The Minnesota Hydrology Guide (MHG) Table 3-1) provides a table for conversion to AMC III for pre-storm conditions.

Spring Runoff (Snowmelt Events)

Spring snowmelt runoff events are also modeled. The amount of 10 day runoff was based on a map in Figure 1-12 of the Minnesota Hydrology Guide which displays expected 10 day runoff amounts for 100 year recurrence events. The estimates were developed from records which include both rainfall and snowmelt runoff estimates. Since most major floods occur in the spring as a result of a combination of rainfall and snowmelt, this data reasonably represents the spring runoff condition. However, in a strict statistical sense, this flood could occur at any time during the year. Factors are also given to estimate runoff amounts for the 50, 25, and 10 year recurrence events. The amount of runoff estimated for each 10 day runoff event in the Roseau area is listed in Table 1. This amount of runoff was used over the entire modeled basin; however, the runoff amount tends to increase from west to east. For individual project assessment, area specific runoff data should be used.

Table 1
Runoff Estimated for 10-day Event

Year	Runoff (Inches)
10	4.03
25	4.88
50	5.49
100	6.1

The 10 day runoff amounts were distributed in time using the SCS procedure described in (NEH, Chapter 21.10) with the following equation:

$$Q_{(\text{max 24 hour})} = .3 * Q_{(\text{10 Day})}$$

This relation means that 30% of the runoff, for the 10 day period, occurs within a 24 hour period. We consider this distribution representative of a typical snowmelt with rainfall event in Northwestern Minnesota. The runoff was distributed equally over the watershed area. Total runoff is simulated in the model by using a SCS curve number of 100 which represents an impervious condition and inputting the runoff amount as precipitation. The assumption that runoff is equally distributed implies that soil infiltration rates are equal. This tends to be true due to the frozen condition of the soil. However, as actual spring flow data is collected, the model can be calibrated to reflect observed differences in spring infiltration rates due to soil type, land cover, or other factors.

Hydrograph Development

For the purpose of hydrograph development at a sub-basin level, the watershed was divided into 97 sub-watersheds. The subwatersheds were shown on the map in Figure 1. Runoff within each sub-watershed is determined, as discussed above, by the SCS curve number method. The curve number determined for each sub-watershed is shown in Table 2. The weighted average 24 hour curve number for the entire drainage area was determined to be 72. This converts to a 10 day curve number of 55 (SCS NEH-4, Table 21.2)

The Clark Unit hydrograph method was used in the model to transform runoff excess to outflow from each sub-watershed. This method requires determination of two runoff parameters related to, time of concentration and storage. The time of concentration was calculated for each sub-watershed. Time of concentration is the travel time required for runoff to flow from the most hydrologically distant point of the sub-watershed to the outlet. The storage coefficients were preliminarily estimated using regional curves developed by the (Red Lake Watershed District, Charles Anderson, P.E.). This uses the relationship: R=K*Tc where R is the storage parameter, K is a drainage/slope coefficient, and Tc is the time of concentration. The Clark Method utilizes time-area curve of the basin for runoff transformation. Synthetic time-area curves were used based on the sub-watershed shape, IE: fan, rectangular, or diamond shape, as presented in the (October 6-9, 1981 workshop on Hydrologic Analysis of Floods, US Army Corps of Engineers in Madison Wisconsin). Sub-watershed hydrologic parameters used in the model are summarized in Table 2.

Table 2
Subwatershed Parameters

Name	Code	DA (Sq Mi)	24-Hour CN	10-Day CN	Tc (Hours)	R (Hours)
Roseau River Flowage	RNF9	40.81	75	58	35.53	82.78
Dam 3	RNF15	13.69	68	50	25.65	51.30
Dam 4	RNF19	5.80	73	56	14.88	29.76
RR to Hanson Creek	RNF25	12.52	62	43	18.80	37.60
Dam 1	RNF29	12.73	75	58	34.28	79.87
Dam 2	RNF35	4.90	65	46	22.66	52.80
Winner Dam	RNF39	13.36	65	46	40.79	95.04
Hanson Creek to RR	RNF45	5.59	57	38	16.96	33.92
Hayes Lake	RNF49	18.29	64	45	60.89	121.78
Beaver	RNF59	15.71	66	47	43.26	64.89
Pencer East	RNF65	12.79	67	49	15.54	12.43
RR to Severson Creek	RNF69	2.29	72	54	7.24	7.24
Severson Creek	RNF70	22.25	68	50	17.30	17.30
RR to Bear Creek	RNF79	7.52	70	52	13.14	13.14
Comstocks	RNF80	20.66	72	55	16.80	14.11
Bear Creek	RNF85	5.27	72	54	11.08	8.64
Gage 2	RNF99	2.18	74	57	3.96	2.65
North Branch		216.09	69	51		
Skime	RNF109	28.21	72	55	67.63	157.58
SB to Mickinock Creek	RNF119	24.20	73	56	25.87	51.74
Palmville Sub RNF3	RNF120	1.27	76	60	7.06	14.12
Palmville Sub RNF4b	RNF121	0.95	78	63	9.62	19.24
Palmville Sub RNF4a	RNF123	2.32	78	62	6.98	13.96
Palmville Sub RNF5	RNF125	4.44	72	54	15.40	30.80
Palmville Sub RNF6	RNF126	1.25	74	57	11.52	17.28
Palmville Sub RNF7	RNF127	2.93	67	48	16.27	16.27
Palmville Sub RNF8	RNF128	1.22	66	47	6.25	9.38

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Name	Code	DA (Sq Mi)	24-Hour CN	10-Day CN	Tc (Hours)	R (Hours)
Palmville Sub RNF9	RNF129	2.90	66	47	7.84	11.76
Palmville Sub RNF10	RNF130	1.29	64	45	5.11	11.91
Palmville wildlife pool	RNF131	7.65	78	62	13.89	32.36
Palmville flood pool	RNF132	0.89	78	62	7.85	18.29
Oseland	RNF139	23.74	73	56	21.3	31.95
Mickinock Creek	RNF145	8.37	72	54	18.97	18.97
Wannaska	RNF149	14.00	72	54	19.28	19.28
SB to Paulson Creek	RNF155	4.45	71	53	6.05	4.05
Gage 43	RNF159	20.07	72	55	20.56	27.76
Paulson Creek	RNF165	3.47	71	53	10.25	10.25
Pencer West	RNF169	6.56	77	61	14.79	14.79
SB to Unamed Creek 1	RNF170	1.65	77	61	6.34	6.34
Unamed Creek 1	RNF171	13.67	72	54	19.15	19.15
SB to Unamed Creek 2	RNF172	5.04	76	60	16.23	16.23
Unamed Creek 2	RNF173	16.03	71	53	16.17	16.17
Gage 3	RNF180	11.52	72	54	18.81	18.81
Sucker Creek	RNF189	0.69	72	55	7.44	4.98
Gage 1	RNF199	9.25	74	57	11.09	11.09
South Branch		218.03	73	55		
Gage 50	RNF209	3.24	72	55	8.83	8.83
Stafford 1	RNF211	11.25	70	52	16.80	11.25
Stafford 2	RNF212	1.45	71	53	2.49	1.67
Stafford 3	RNF213	0.70	66	47	5.56	3.73
County Ditch 8	RNF219	6.26	71	53	17.92	17.92
RR to Cow Creek	RNF229	4.83	71	53	12.04	12.04
Gage 44	RNF248	16.90	72	55	15.15	15.15
Cow Creek	RNF249	0.31	75	58	1.76	1.76
Center Street	RNF269	5.07	76	60	10.04	10.04
Roseau River at Center Street		484.13	71	53		
Gage 15	RNF299	5.51	76	60	9.18	9.18
County Road 2	RNF319	19.38	74	57	17.12	16.95

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Name	Code	DA (Sq Mi)	24-Hour CN	10-Day CN	Tc (Hours)	R (Hours)
Upper Summer Road	RNF335	10.04	69	51	19.28	19.28
Summer Road	RNF339	10.50	67	49	17.20	17.20
Upper SE Hwy11	RNF351	4.32	72	55	12.99	12.99
Gage 12	RNF359	12.44	68	50	13.97	14.39
MN Highway 11	RNF379	20.97	72	54	37.80	56.70
Hay Creek Det 1	RNF381	4.14	72	54	20.23	20.23
Norland CD 18	RNF385	8.39	72	55	29.83	59.66
Hay Creek Pool 1	RNF391	2.21	72	55	3.60	3.60
Lower Hay Creek	RNF399	19.76	71	53	24.80	31.00
Hay Creek		112.15	71	53		
Norland sub RNF20	RNF401	2.85	74	57	6.27	9.41
Norland sub RNF30	RNF402	6.43	72	54	39.75	79.50
Norland sub RNF40	RNF403	5.66	67	49	13.51	13.51
Norland sub RNF60	RNF405	7.08	72	55	11.04	11.04
Norland sub RNF65	RNF406	1.71	65	46	5.00	5.85
Norland sub RNF70	RNF408	7.65	67	48	12.55	18.83
MN Highway 310	RNF499	19.26	67	49	18.59	32.35
Roseau River @ MN 310		652.43	71	53		
Mud Creek near Sprague, MB	RNF510	32.18	75	59	71.13	106.70
East Fork Sprague Creek	RNF520	22.42	68	51	43.20	64.80
West Fork Sprague Creek	RNF530	20.42	64	45	48.32	72.48
Sprague Creek at Vassar Road	RNF540	47.64	69	51	43.35	65.03
Sprague Creek near Sprague, MB	RNF545	21.93	74	57	35.70	53.55
Sprague Creek at USGS gage	RNF550	39.01	72	55	52.83	35.40
Lat 2 JD 61	RNF570	54.33	76	60	39.24	58.86
Lower Sprague Creek	RNF580	47.32	78	62	29.00	43.50
Sprague Creek		285.25	73	56		
South Roseau Lake	RNF610	40.91	71	53	10.48	7.02
North Roseau Lake	RNF620	46.20	72	55	40.11	40.11
West Pine Creek	RNF700	33.76	62	43	56.23	37.67
East Pine Creek	RNF710	9.55	60	41	20.36	13.63

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Name	Code	DA (Sq Mi)	24-Hour CN	10-Day CN	Tc (Hours)	R (Hours)
Pine Creek to Diversion	RNF720	16.68	67	49	7.58	5.08
Pine Creek at Gage 19	RNF790	20.29	73	56	17.76	17.76
Pine Creek		80.28	66	47		
Roseau River at Ross		1105.07	71	54		
RRWMA Pool 1	RNF810	24.88	75	58	13.30	13.30
RRWMA Pool 2	RNF820	89.71	75	58	51.00	76.50
RRWMA Pool 3	RNF830	23.73	70	52	12.50	12.50
Lins Bridge	RNF900	41.99	72	54	14.73	9.87
RR to Big Swamp	RNF920	24.09	75	59	32.83	32.83
Big Swamp	RNF950	88.82	78	63	32.48	48.72
Caribou	RNF960	24.04	71	53	24.04	33.80
Roseau River to Int'l Border	RNF999	9.56	70	52	13.78	13.78
Roseau River at Int'l Border		1431.89	72	55		

Reach Routing

Roseau River HEC-1 Hydrologic Model (July 18, 2001)

The channel reaches were modeled using the Modified Puls routing method. This method requires the input of an eight point cross section, Mannings (n value) for channel and overbank flow, reach length, slope, and the number of routing steps.

The channel cross section, reach length, and slope were derived from (USGS 7.5 minute topographic maps). Cross section data from the stream gaging program the District operates were also used. The number of routing steps is a calibration parameter for storage routing, it was set to reflect average flows as measured in the Districts stream gaging program. As actual storm events are studied this number should be varied to produce a more accurate hydrograph.

Calibration

Model calibration was done on two rainfall events, the first occuring in May of 1996 and the later occurring in October of 2000. The results of this calibration is shown in Figures 6-12. The gage on Sprague Creek was not in operation for the 1996 flood.

The initial runs of these floods produced higher peaks and shorter durations than the gaged data. The total volume of the events were about equal so calibration was done by adjusting storage upstream of the gaging site. As more gaging data becomes available on the tributaries, this storage can be distributed better.

Results and Conclusions

The model can be used to evaluate the relative change to the flood hydrograph with and without projects which are being considered in the basin. The ability to evaluate relative difference (as apposed to predicting absolute values) is the strength of the hydrologic modeling process.

Tables 3, 4, and 5 show a summary of model predicted peak flows at various points in the basin. These predicted peak flows are considered reasonable. However, care should be taken in using model predicted peak flows for project design purposes. Modeling is only one of the methods normally used for project design.

Figure 6

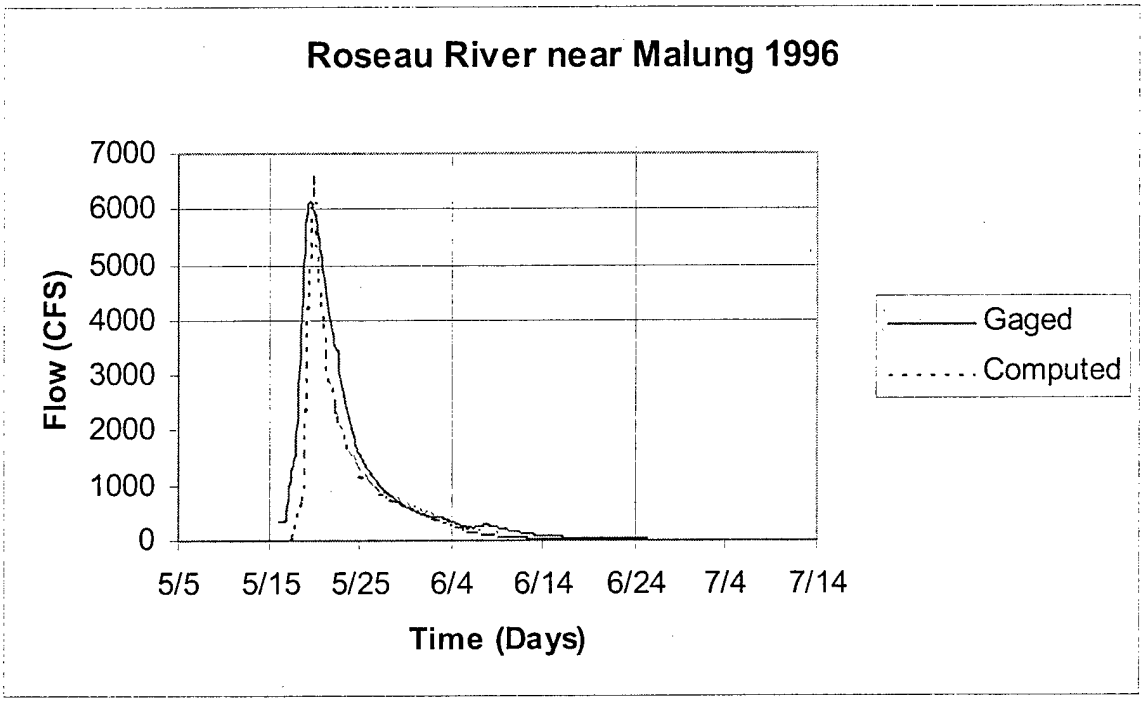

Roseau River near Malung 1996
7000
6000
5000
4000
3000
2000
1000
0
Flow (CFS)
5/5
5/15
5/25
6/4
6/14
6/24
7/4
7/14
Time (Days)
Gaged
Computed

Figure 7

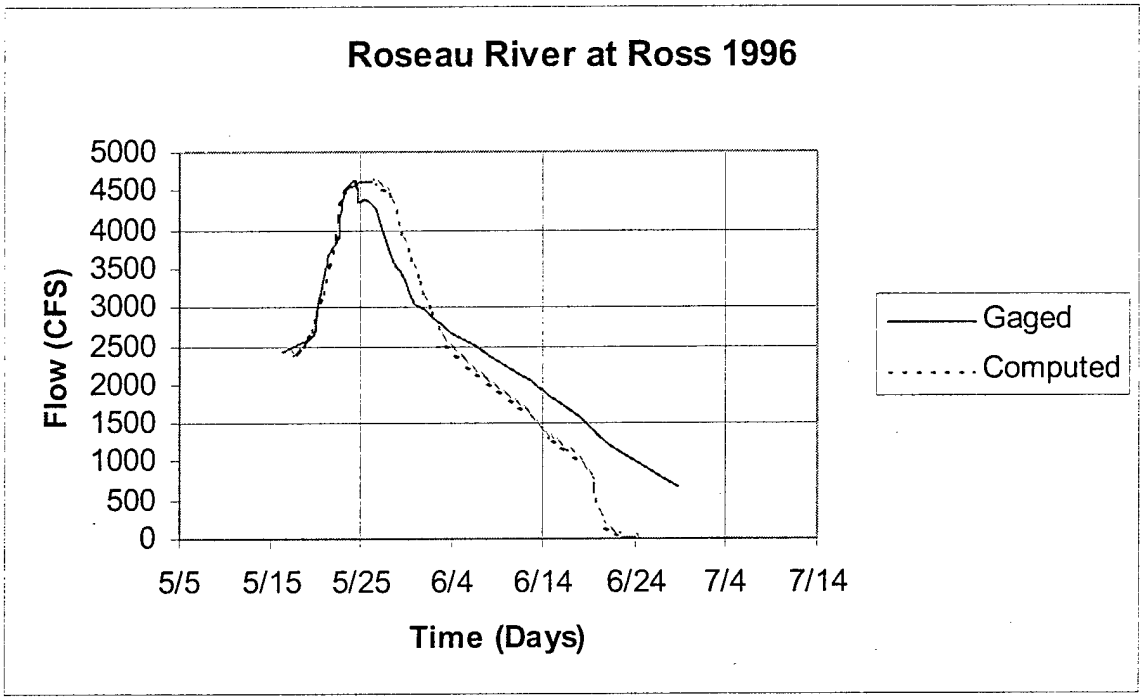

Roseau River at Ross 1996
Flow (CFS)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
5/5
5/15
5/25
6/4
6/14
6/24
7/4
7/14
Time (Days)
Gaged
Computed

Figure 8

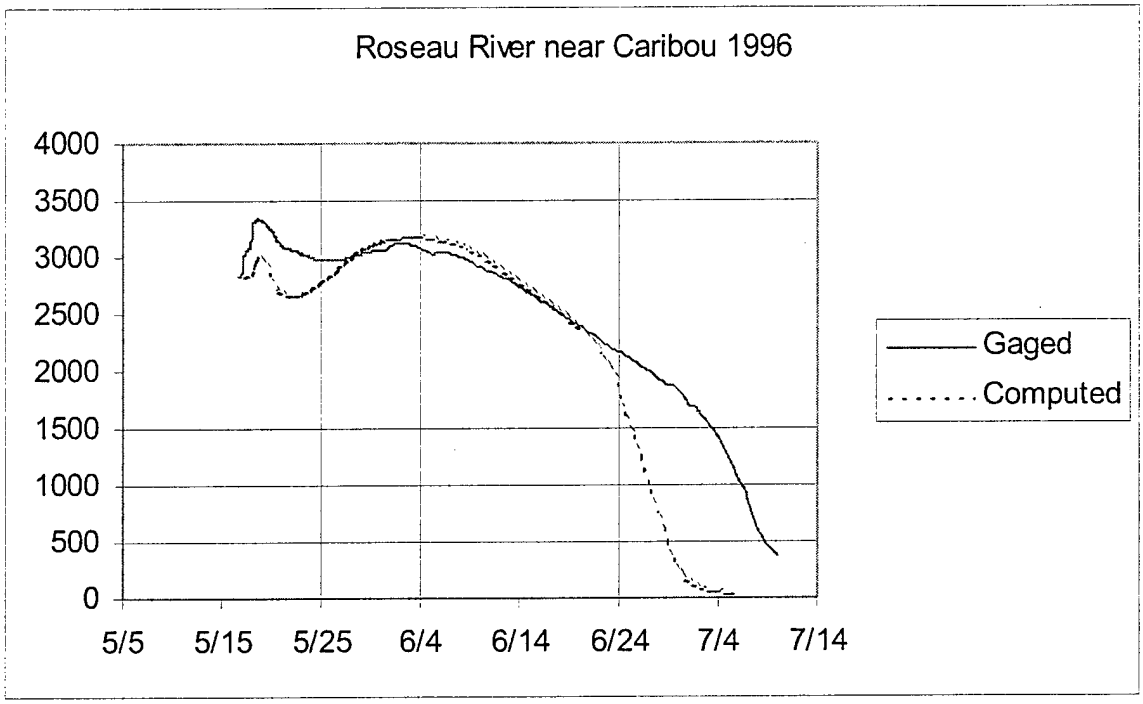

Roseau River near Caribou 1996
4000
3500
3000
2500
2000
1500
1000
500
0
5/5
5/15
5/25
6/4
6/14
6/24
7/4
7/14
Gaged
Computed

Figure 9

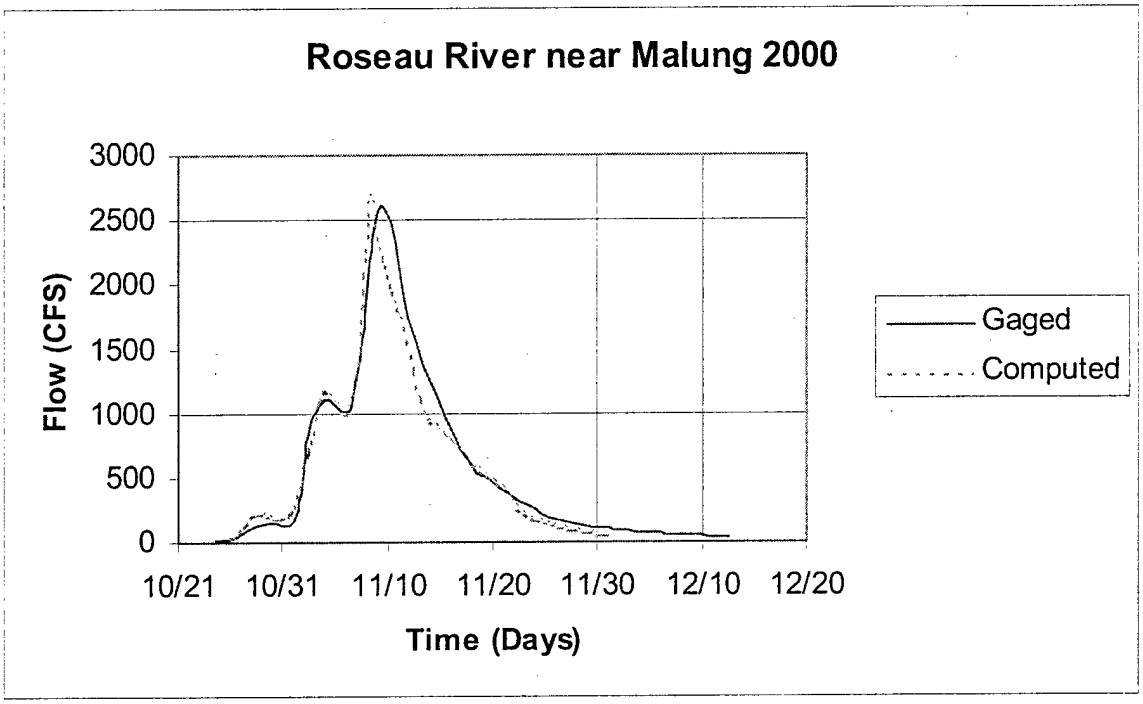

Roseau River near Malung 2000
3000
2500
2000
1500
1000
500
0
Flow (CFS)
10/21
10/31
11/10
11/20
11/30
12/10
12/20
Time (Days)
Gaged
Computed

Figure 10

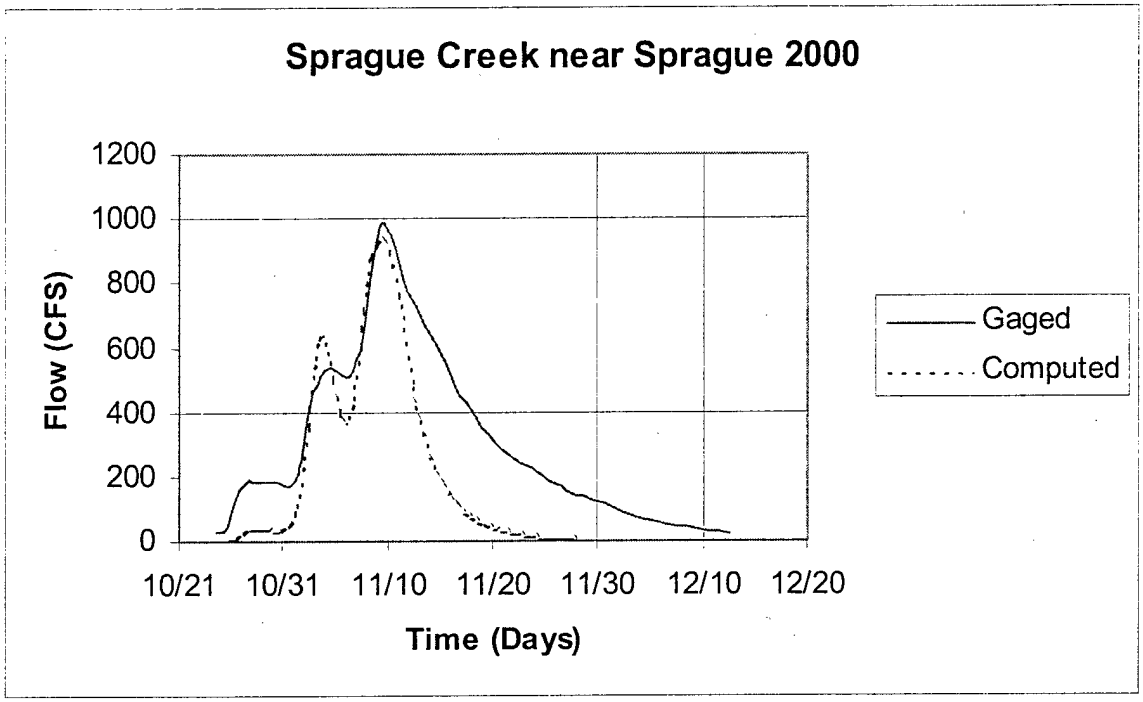

Sprague Creek near Sprague 2000
1200
1000
800
600
400
200
0
Flow (CFS)
10/21
10/31
11/10
11/20
11/30
12/10
12/20
Time (Days)
Gaged
Computed

Figure 11

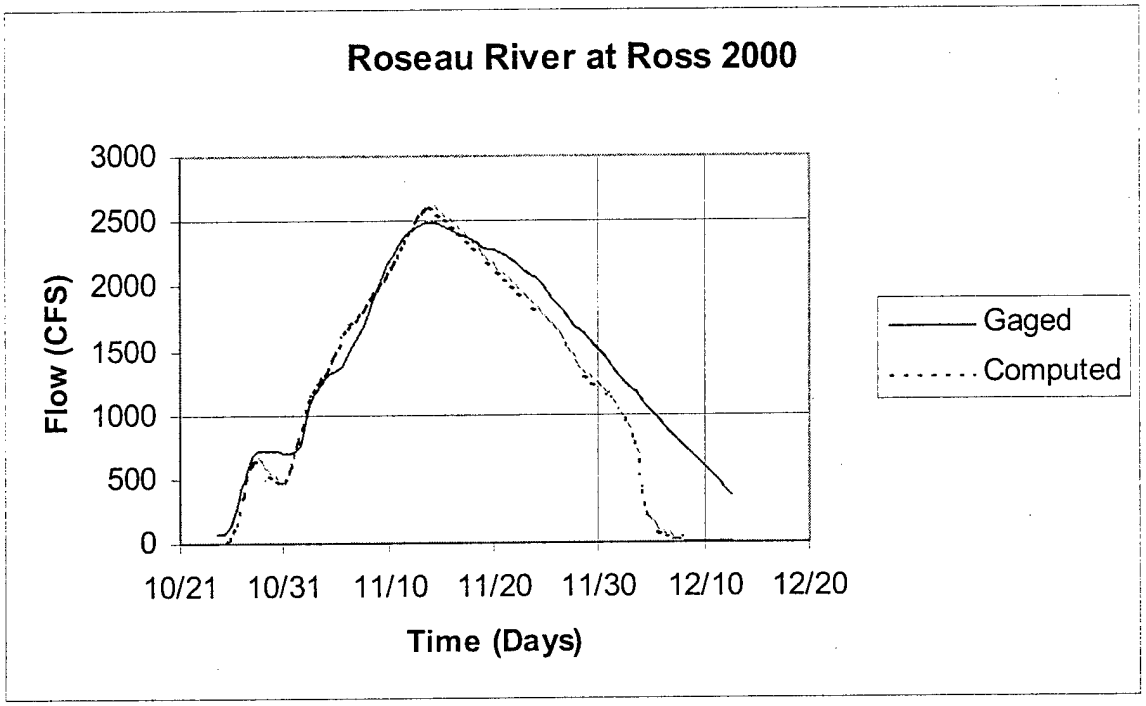
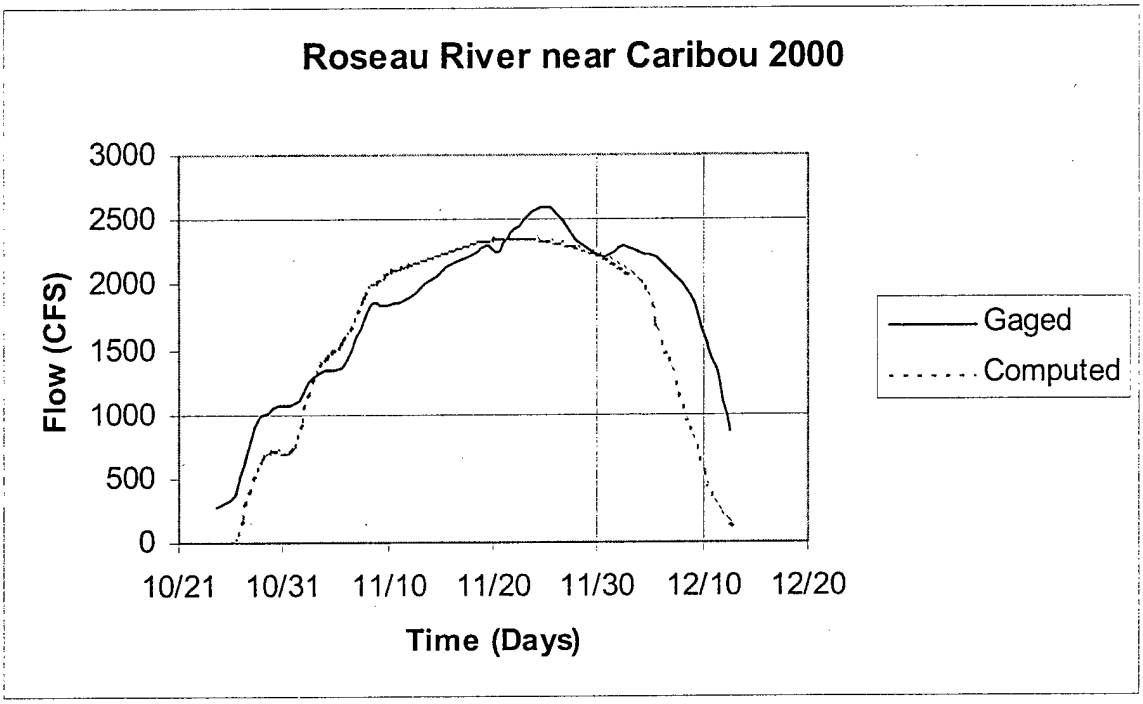

Roseau River at Ross 2000
3000
2500
2000
1500
1000
500
0
Flow (CFS)
10/21
10/31
11/10
11/20
11/30
12/10
12/20
Time (Days)
Gaged
Computed

Figure 12


Roseau River near Caribou 2000
3000
2500
2000
1500
1000
500
0
Flow (CFS)
10/21
10/31
11/10
11/20
11/30
12/10
12/20
Time (Days)
Gaged
Computed

Roseau River HEC-1 Hydrologic Model (July 18, 2001)

Table 3
Summary of Synthetic Summer Flood Flows

Location	Stream Gage ID	Model Id	Drainage Area	1 yr (cfs)	2 yr (cfs)	5 yr (cfs)	10 yr (cfs)
North Branch near Malung	2	adh99	216.09	63	82	295	499
South Fork at Wannaska	36	adh149	125.63	144	170	560	1,027
South Fork near Malung	1	adh199	218.03	148	187	440	973
Roseau River near Malung	50	adh209	437.36	198	258	729	1,411
Roseau River at Roseau	30	adh269	484.13	214	283	793	1,533
Hay Creek at Summer Road	11	adh339	45.43	51	61	245	482
Hay Creek at MN Hwy 11	13	adh379	83.16	83	100	397	779
Hay Creek at Mouth		adh399	112.15	110	133	524	821
Roseau River at CR 28	15	adh400	601.79	275	362	1,067	2,159
Roseau River at MN Hwy 310	16	adh499	652.43	296	390	1,224	2,280
Sprague Creek at USGS Gage	57	adh550	183.60	135	160	554	984
Sprague Creek		adh580	285.25	294	338	961	1,673
Pine Creek at Diversion	606	adh720	59.99	12	16	130	345
Pine Creek Diversion	606	rtv720		12	16	130	303
Pine Creek at CR 118	19	adh790	80.28	39	47	171	324
Roseau River at Ross	20	rsv699	1,105.07	646	755	1,365	1,968
Overflow to Two Rivers	40	rtv920		0	0	0	4
Roseau River near Caribou		adh960	1,422.33	732	839	1,448	2,008
Roseau River at Int'l Border		adh999	1,432.89	733	839	1,448	2,008

Roseau River HEC-1 Hydrologic Model (July 18, 2001)

Table 4
Summary of Synthetic Summer Flood Flows

Location	Stream Gage ID	Model Id	Drainage Area	25 yr (cfs)	50 yr (cfs)	100 yr (cfs)
North Branch near Malung	2	adh99	216.09	999	1,617	2,052
South Fork at Wannaska	36	adh149	125.63	1,621	2,088	2,500
South Fork near Malung	1	adh199	218.03	2,321	3,568	4,302
Roseau River near Malung	50	adh209	437.36	2,781	4,106	5,230
Roseau River at Roseau	30	adh269	484.13	3,184	4,725	5,840
Hay Creek at Summer Road	11	adh339	45.43	770	1,007	1,209
Hay Creek at MN Hwy 11	13	adh379	83.16	1,185	1,518	1,805
Hay Creek at Mouth		adh399	112.15	1,247	1,610	1,944
Roseau River at CR 28	15	adh400	601.79	4,053	5,340	6,600
Roseau River at MN Hwy 310	16	adh499	652.43	3,781	5,082	6,113
Sprague Creek at USGS Gage	57	adh550	183.60	1,427	1,847	2,164
Sprague Creek		adh580	285.25	2,462	3,164	3,727
Pine Creek at Diversion	606	adh720	59.99	629	878	1,100
Pine Creek Diversion	606	rtv720		493	658	784
Pine Creek at CR 118	19	adh790	80.28	557	755	923
Roseau River at Ross	20	rsv699	1,105.07	2,698	3,772	4,514
Overflow to Two Rivers	40	rtv920		186	380	557
Roseau River near Caribou		adh960	1,422.33	2,342	2,697	3,008
Roseau River at Int'l Border		adh999	1,432.89	2,342	2,697	3,007

Table 5
Summary of Synthetic Spring Flood Flows

Location	Stream Gage ID	Model Id	Drainage Area	10 yr (cfs)	25 yr (cfs)	50 yr (cfs)	100 yr (cfs)
North Branch near Malung	2	adh99	216.09	3,168	3,880	4,365	4,845
South Fork at Wannaska	36	adh149	125.63	2,237	2,721	3,066	3,416
South Fork near Malung	1	adh199	218.03	3,969	4,673	5,224	5,802
Roseau River near Malung	50	adh209	437.36	7,164	8,484	9,485	10,433
Roseau River at Roseau	30	adh269	484.13	8,100	9,587	10,465	11,572
Hay Creek at Summer Road	11	adh339	45.43	928	1,119	1,257	1,396
Hay Creek at MN Hwy 11	13	adh379	83.16	1,622	1,954	2,195	2,440
Hay Creek at Mouth		adh399	112.15	1,902	2,337	2,639	2,954
Roseau River at CR 28	15	adh400	601.79	8,534	10,039	11,171	12,267
Roseau River at MN Hwy 310	16	adh499	652.43	8,038	9,819	10,996	12,142
Sprague Creek at USGS Gage	57	adh550	183.60	2,489	3,020	3,434	3,829
Sprague Creek		adh580	285.25	3,852	4,708	5,337	5,966
Pine Creek at Diversion	606	adh720	59.99	1,127	1,470	1,654	1,838
Pine Creek Diversion	606	rtv720		796	850	850	850
Pine Creek at CR 118	19	adh790	80.28	792	1,182	1,432	1,684
Roseau River at Ross	20	rsv699	1,105.07	5,136	6,741	8,160	9,798
Overflow to Two Rivers	40	rtv920		1,334	1,793	2,235	2,740
Roseau River near Caribou		adh960	1,422.33	3,449	3,687	3,915	4,175
Roseau River at Int'l Border		adh999	1,432.89	3,449	3,687	3,915	4,175

Future Model Improvements

The model has had limited calibration to actual storm events due to the limited extent of actual gaging data available, particularly in Manitoba. We have established a network of stream gaging sites within the watershed. The location of these sites are shown in Figure 14. We recommend that as additional data from these sites becomes available, further calibration of the model should be performed.

The modeling capabilities of the program are somewhat limited in their ability to model the sloped storage that occurs in the Old Roseau Lake Bed and the Big Swamp areas. Within the current model, this is done by an approximation of level pool storage. Ideally, these areas would be analyzed using a dynamic routing model such as Unet.

As the planning process evolves, it is anticipated that the model will need to be further refined to analyze specific flood damage reduction strategies in specific areas.

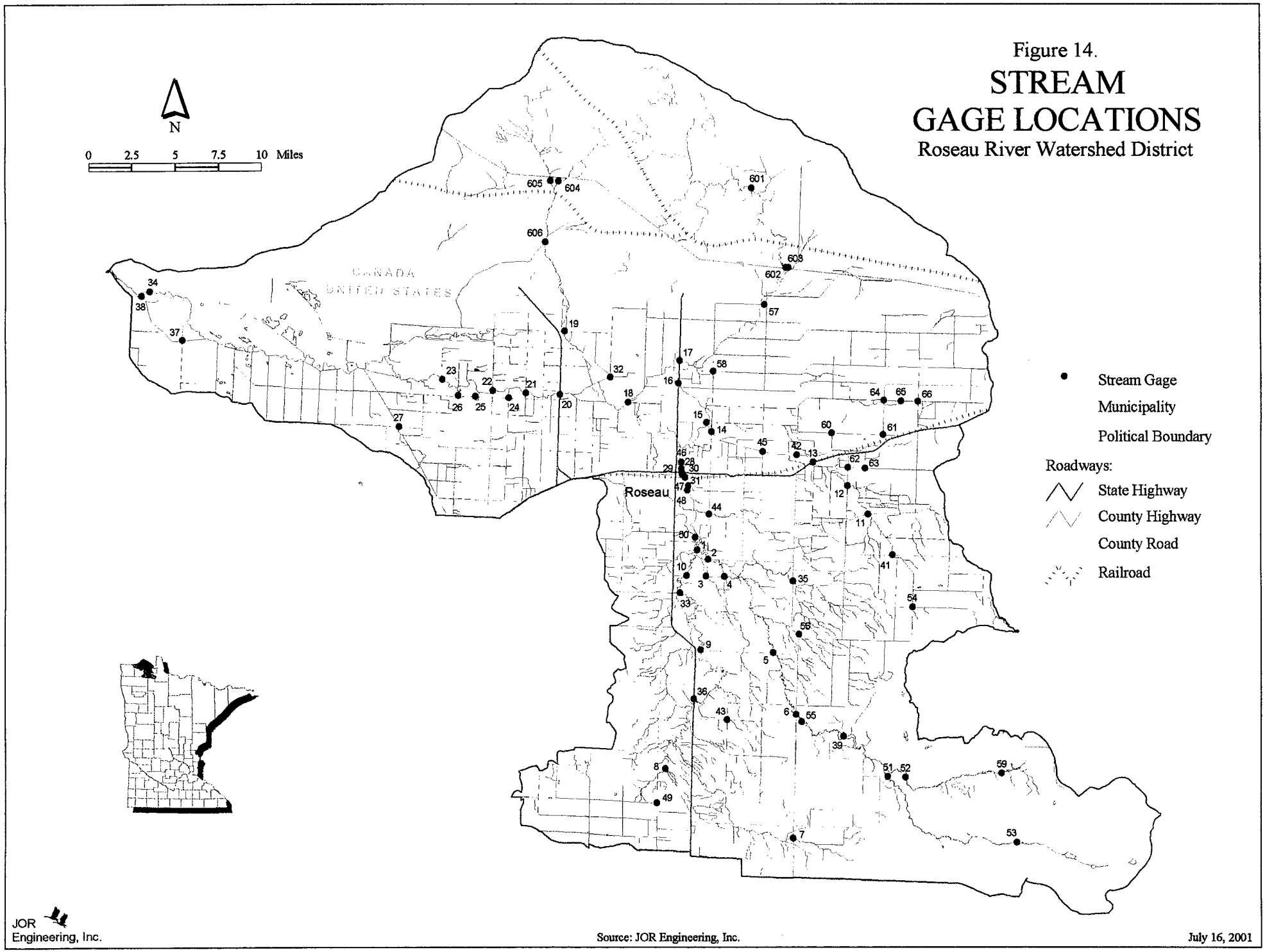


Figure 14.
STREAM
GAGE LOCATIONS
Roseau River Watershed District
N
0 2.5 5 7.5 10 Miles
CANADA
UNITED STATES
Roseau
Stream Gage
Municipality
Political Boundary
Roadways:
State Highway
County Highway
County Road
Railroad
JOR
Engineering, Inc.
Source: JOR Engineering, Inc.
July 16, 2001

References

→ Minnesota Soil Atlas Miscellaneous Report 173-1980

→ Joint Studies for Co-ordinated Water Use and Control in the Roseau River Basin, International Roseau River Engineering Board Report to the International Joint Commission, September, 1975, Appendix A Water Resources

→ National Weather Service, Technical Papers #40 and 49

→ Soil Conservation Service, National Engineering Handbook (NEH)

→ United States Department of Agriculture, Soil Survey Manual, Soil Survey Division Staff, Agriculture Handbook No. 18, Issued October 1993

→ The Minnesota Hydrology Guide (MHG)

→ Red Lake Watershed District, Charles Anderson, P.E.

→ Hydrologic Analysis of Floods, Workshop - U.S. Army Corps of Engineers, October 6-9, 1981 Madison, Wisconsin

→ USGS 7.5 Minute Topographic Maps

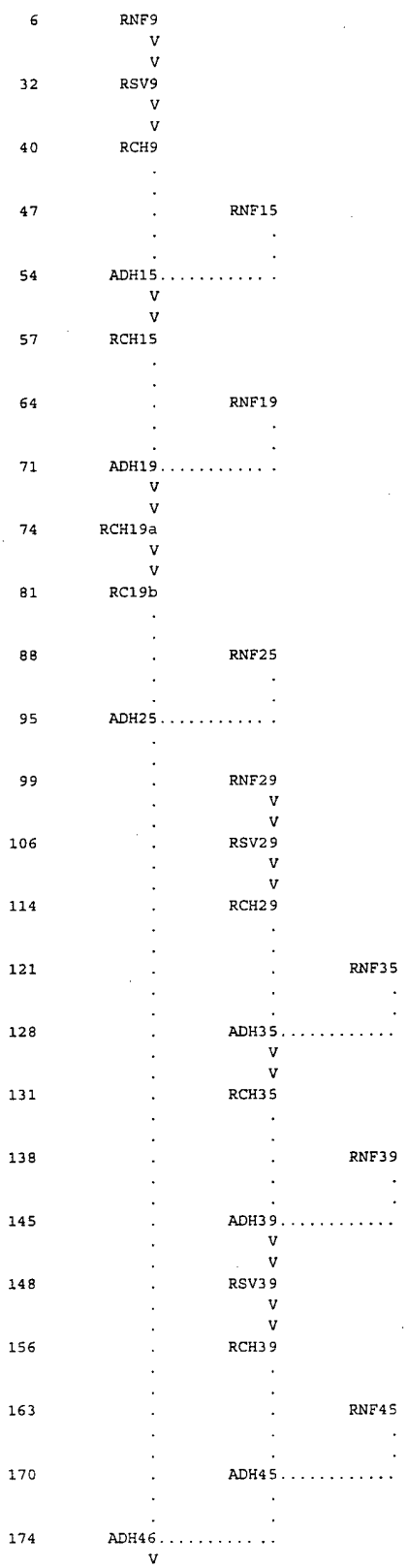
APPENDIX A

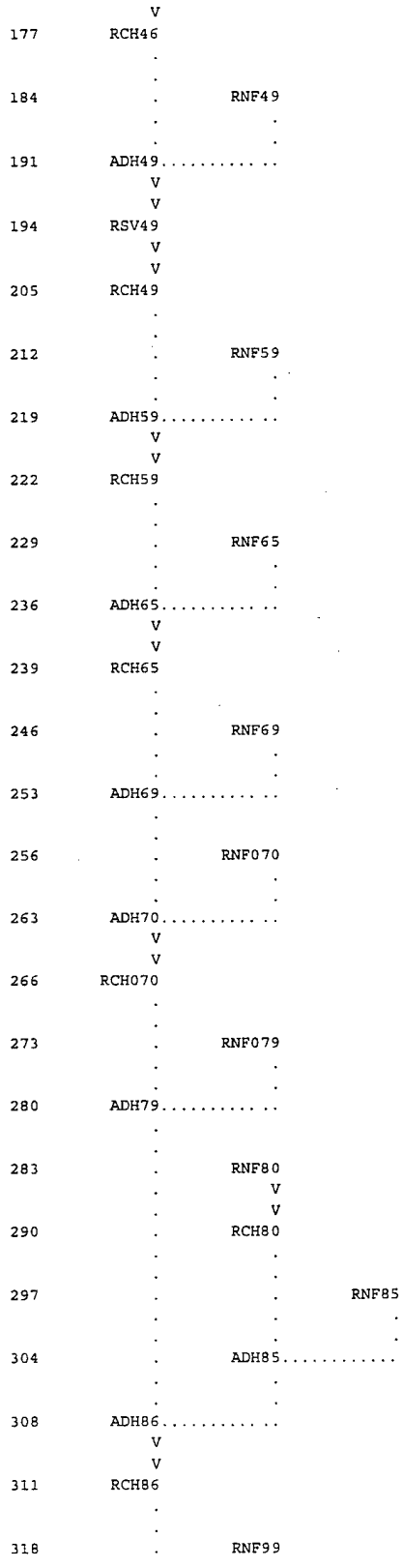
Basin Schematic

SCHEMATIC DIAGRAM OF STREAM NETWORK

INPUT
LINE NO.

(V) ROUTING
(.) CONNECTOR
(---->) DIVERSION OR PUMP FLOW
(<----) RETURN OF DIVERTED OR PUMPED FLOW


6 RNF9
32 RSV9
40 RCH9
47 RNF15
54 ADH15
57 RCH15
64 RNF19
71 ADH19
74 RCH19a
81 RC19b
88 RNF25
95 ADH25
99 RNF29
106 RSV29
114 RCH29
121 RNF35
128 ADH35
131 RCH35
138 RNF39
145 ADH39
148 RSV39
156 RCH39
163 RNF45
170 ADH45
174 ADH46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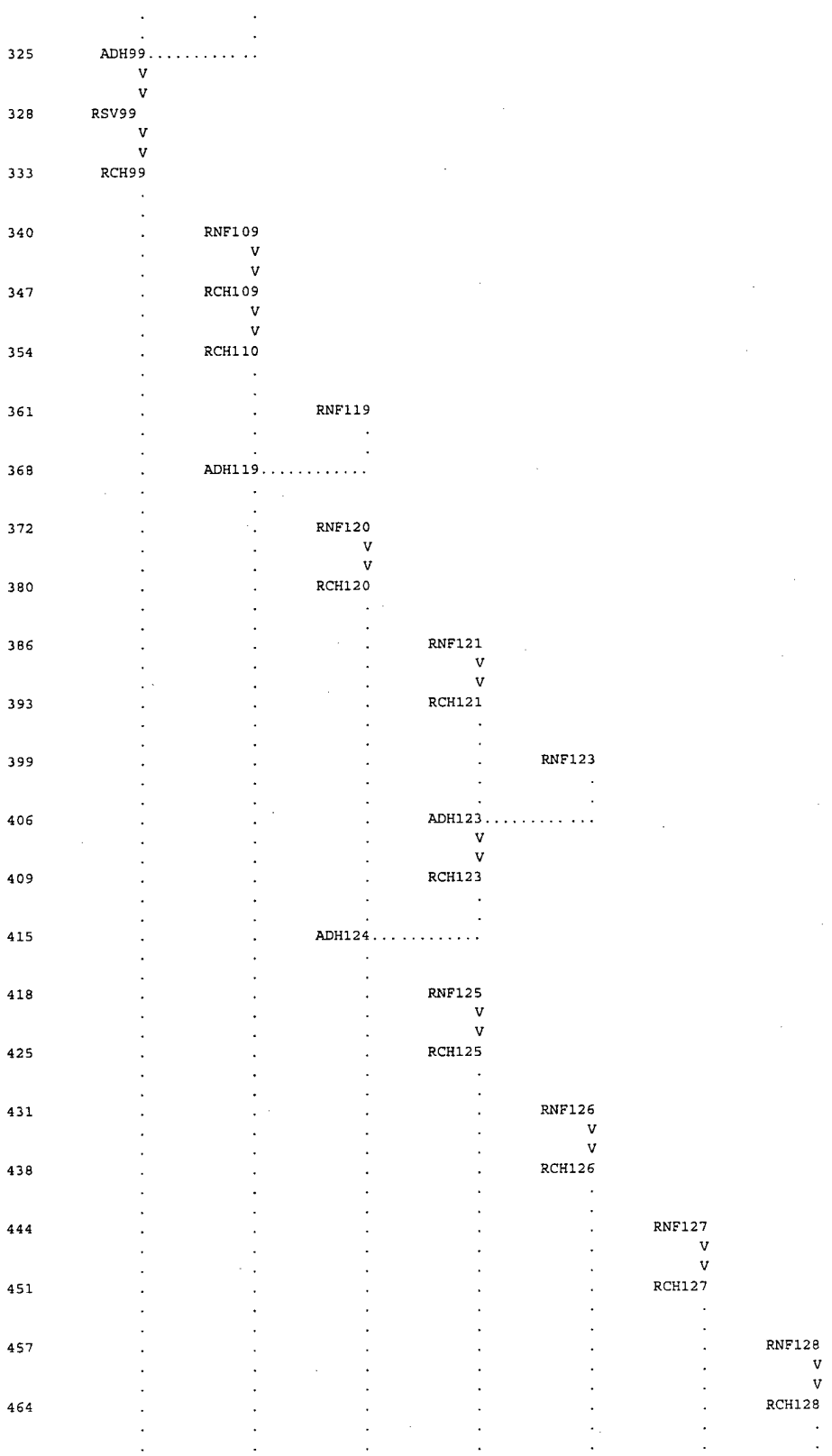
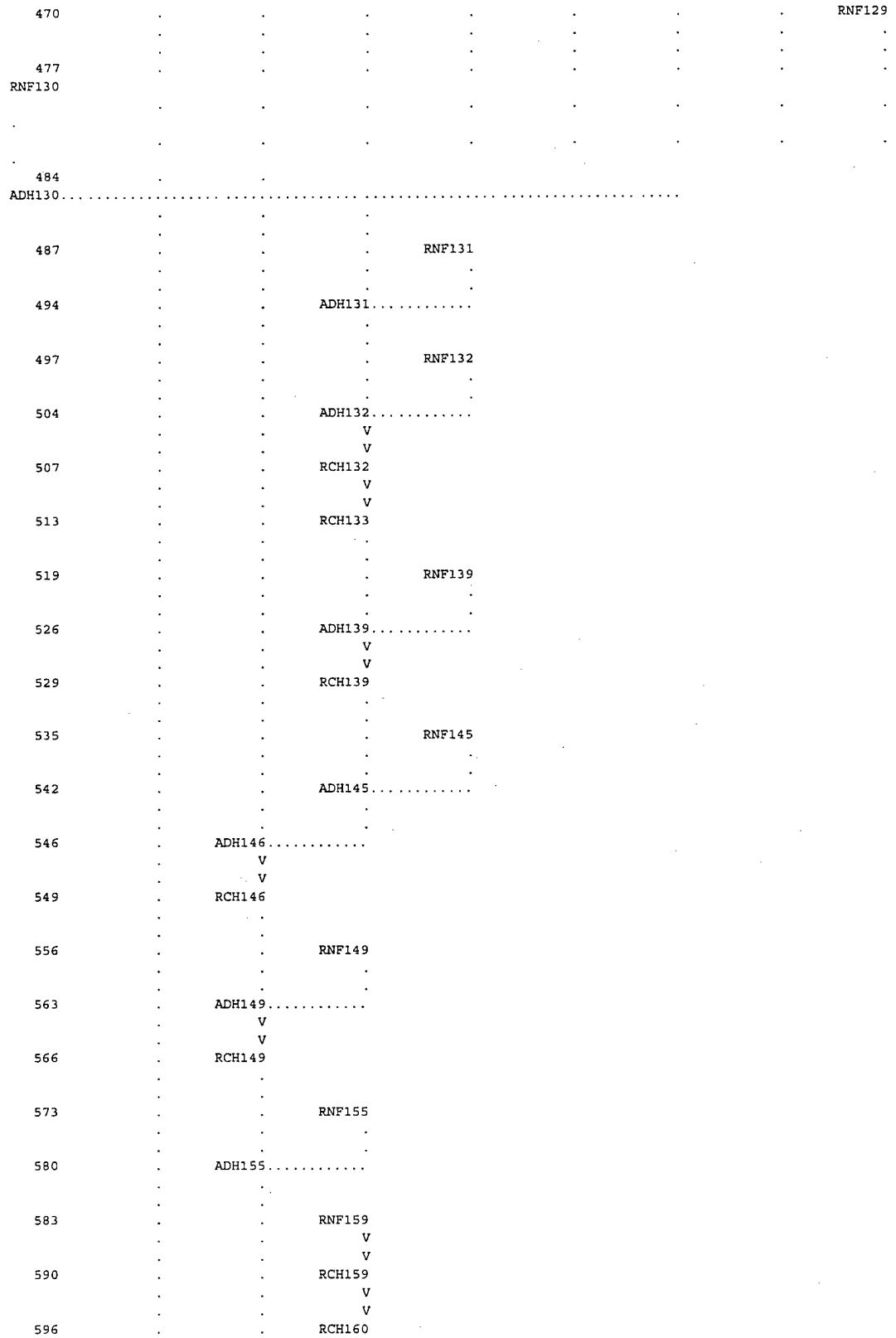
184 RNF49
191 ADH49
194 RSV49
205 RCH49
212 RNF59
219 ADH59
222 RCH59
229 RNF65
236 ADH65
239 RCH65
246 RNF69
253 ADH69
256 RNF070
263 ADH70
266 RCH070
273 RNF079
280 ADH79
283 RNF80
290 RCH80
297 RNF85
304 ADH85
308 ADH86
311 RCH86
318 RNF99


325 ADH99
328 RSV99
333 RCH99
340 RNF109
347 RCH109
354 RCH110
361 RNF119
368 ADH119
372 RNF120
380 RCH120
386 RNF121
393 RCH121
399 RNF123
406 ADH123
409 RCH123
415 ADH124
418 RNF125
425 RCH125
431 RNF126
438 RCH126
444 RNF127
451 RCH127
457 RNF128
464 RCH128


470
RNF129
477
RNF130
484
ADH130
487
RNF131
494
ADH131
497
RNF132
504
ADH132
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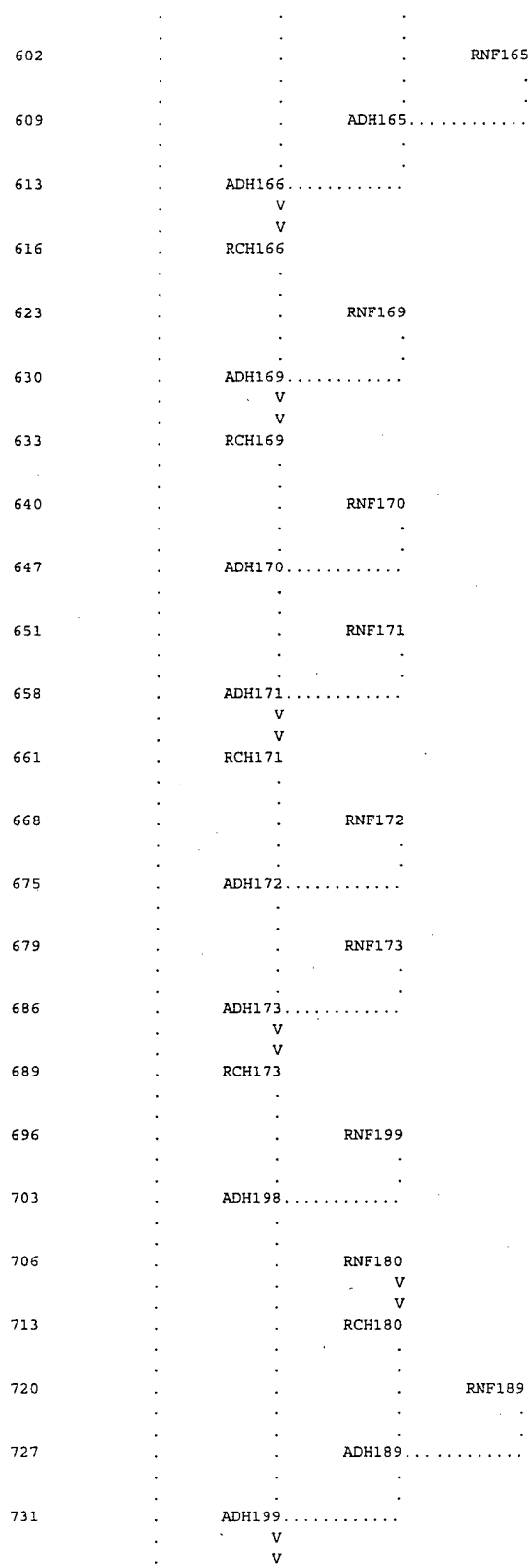
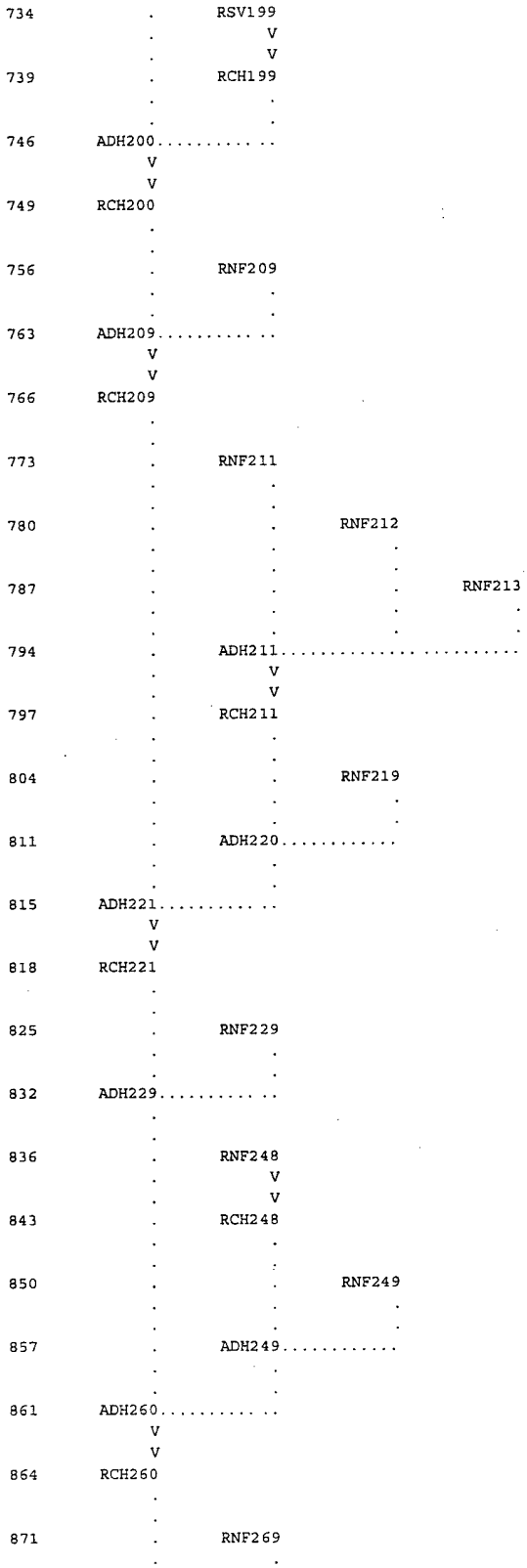
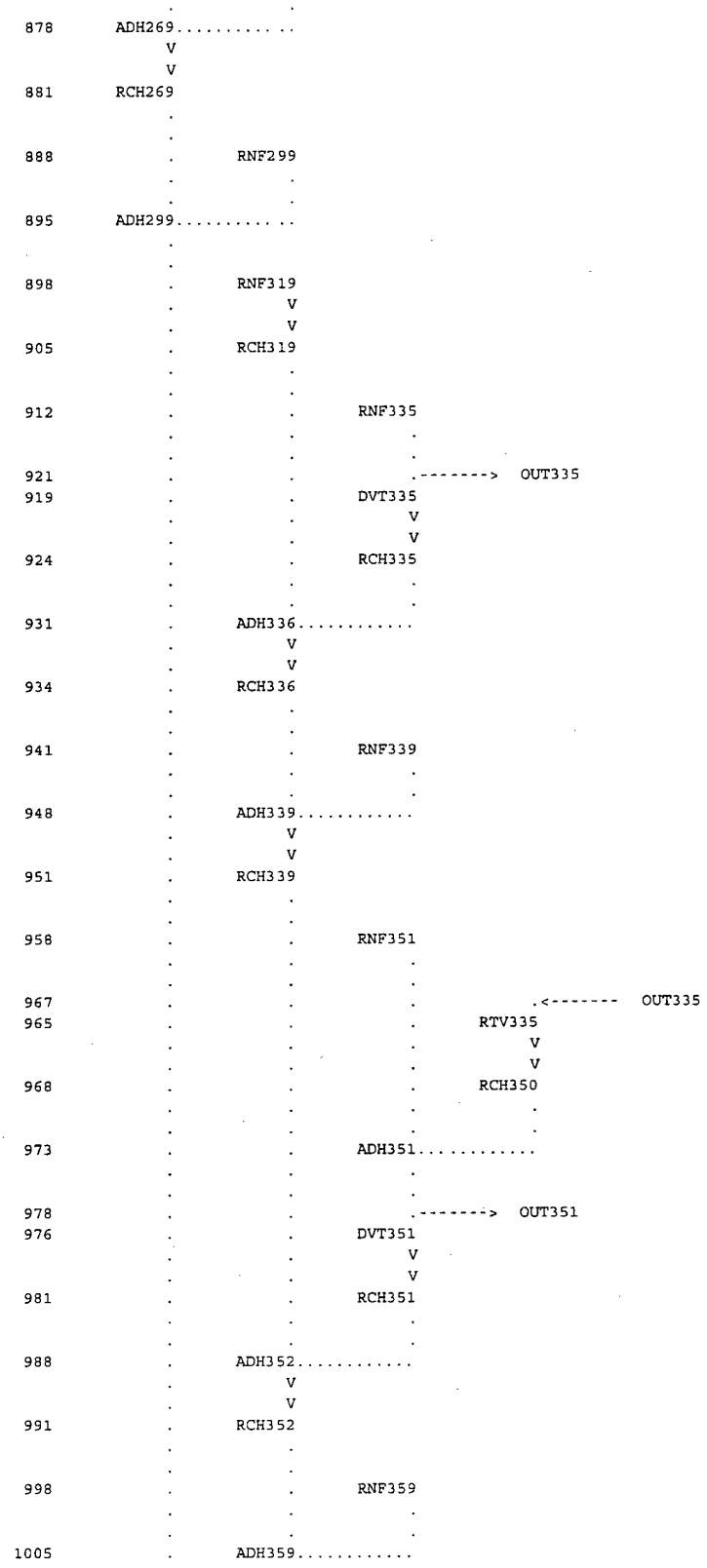
RCH132
513
RCH133
519
RNF139
526
ADH139
529
RCH139
535
RNF145
542
ADH145
546
ADH146
549
RCH146
556
RNF149
563
ADH149
566
RCH149
573
RNF155
580
ADH155
583
RNF159
590
RCH159
596
RCH160


602 RNF165
609 ADH165
613 ADH166
616 RCH166
623 RNF169
630 ADH169
633 RCH169
640 RNF170
647 ADH170
651 RNF171
658 ADH171
661 RCH171
668 RNF172
675 ADH172
679 RNF173
686 ADH173
689 RCH173
696 RNF199
703 ADH198
706 RNF180
713 RCH180
720 RNF189
727 ADH189
731 ADH199


734 RSV199
739 RCH199
746 ADH200
749 RCH200
756 RNF209
763 ADH209
766 RCH209
773 RNF211
780 RNF212
787 RNF213
794 ADH211
797 RCH211
804 RNF219
811 ADH220
815 ADH221
818 RCH221
825 RNF229
832 ADH229
836 RNF248
843 RCH248
850 RNF249
857 ADH249
861 ADH260
864 RCH260
871 RNF269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881 RCH269
888 RNF299
895 ADH299
898 RNF319
905 RCH319
912 RNF335
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919 DVT335
924 RCH335
931 ADH336
934 RCH336
941 RNF339
948 ADH339
951 RCH339
958 RNF351
967 OUT335
965 RTV335
968 RCH350
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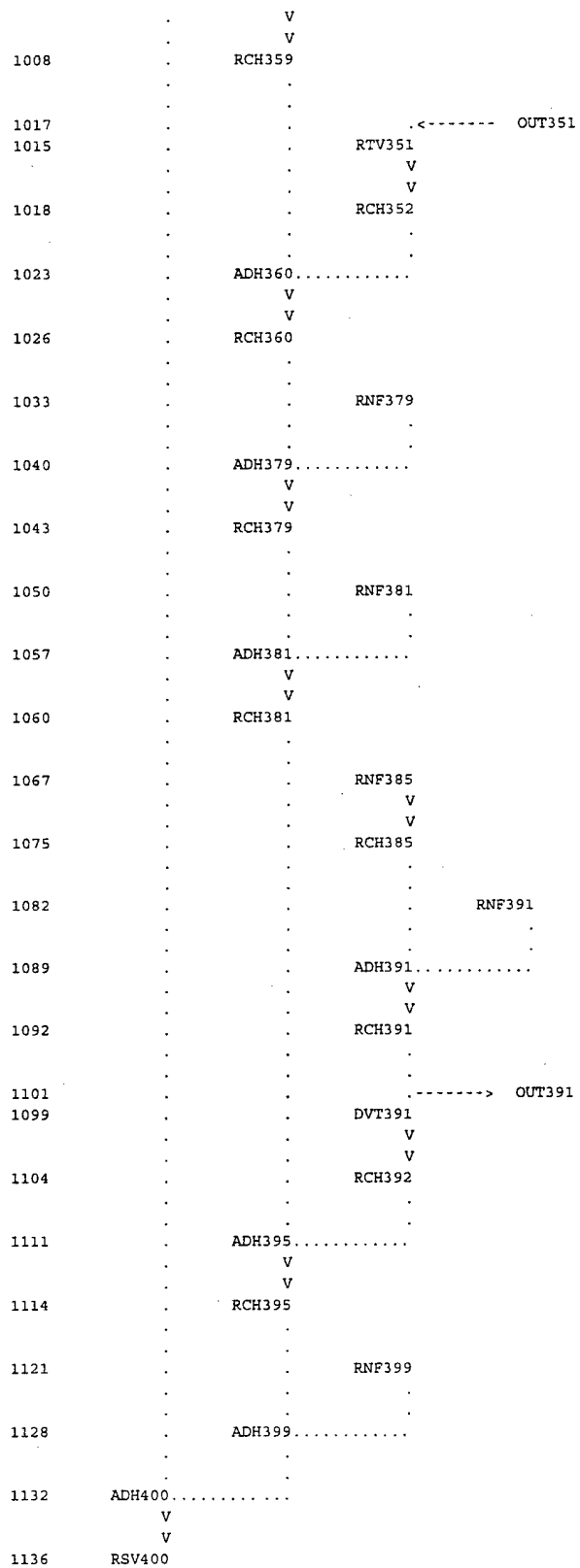
998 RNF359
1005 ADH359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1017 <-------- OUT351
1015 RTV351
1018 RCH352
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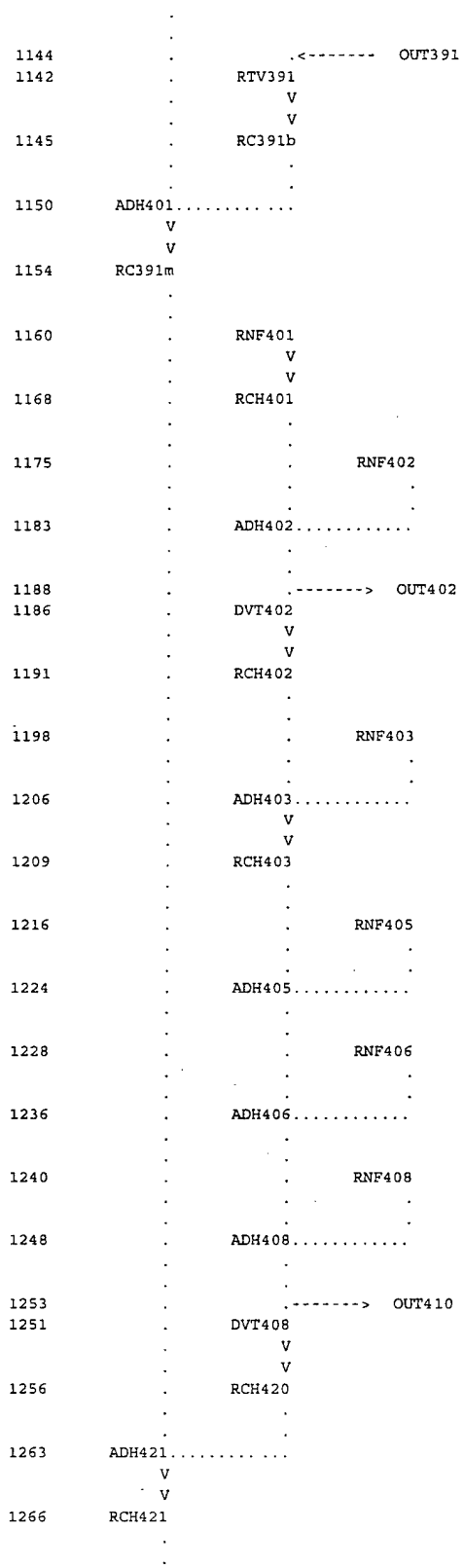
1026 RCH360
1033 RNF379
1040 ADH379
1043 RCH379
1050 RNF381
1057 ADH381
1060 RCH381
1067 RNF385
1075 RCH385
1082 RNF391
1089 ADH391
1092 RCH391
1101 --------> OUT391
1099 DVT391
1104 RCH392
1111 ADH395
1114 RCH395
1121 RNF399
1128 ADH399
1132 ADH400
1136 RSV400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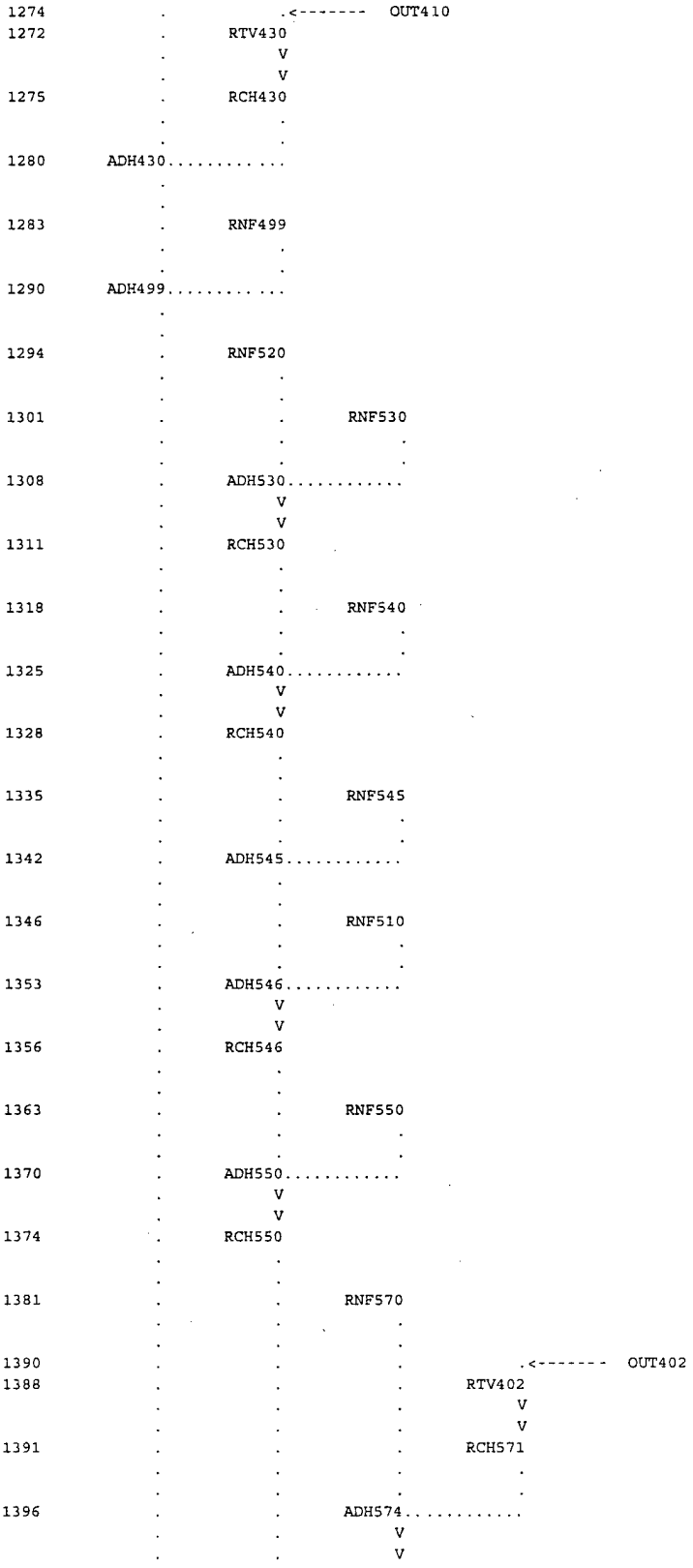
1142 RTV391
V
V
1145 RC391b
1150 ADH401
V
V
1154 RC391m
1160 RNF401
V
V
1168 RCH401
1175 RNF402
1183 ADH402
1188 .-------> OUT402
1186 DVT402
V
V
1191 RCH402
1198 RNF403
1206 ADH403
V
V
1209 RCH403
1216 RNF405
1224 ADH405
1228 RNF406
1236 ADH406
1240 RNF408
1248 ADH408
1253 .-------> OUT410
1251 DVT408
V
V
1256 RCH420
1263 ADH421
V
V
1266 RCH421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1272 RTV430
V
V
1275 RCH430
1280 ADH430
1283 RNF499
1290 ADH499
1294 RNF520
1301 RNF530
1308 ADH530
V
V
1311 RCH530
1318 RNF540
1325 ADH540
V
V
1328 RCH540
1335 RNF545
1342 ADH545
1346 RNF510
1353 ADH546
V
V
1356 RCH546
1363 RNF550
1370 ADH550
V
V
1374 RCH550
1381 RNF570
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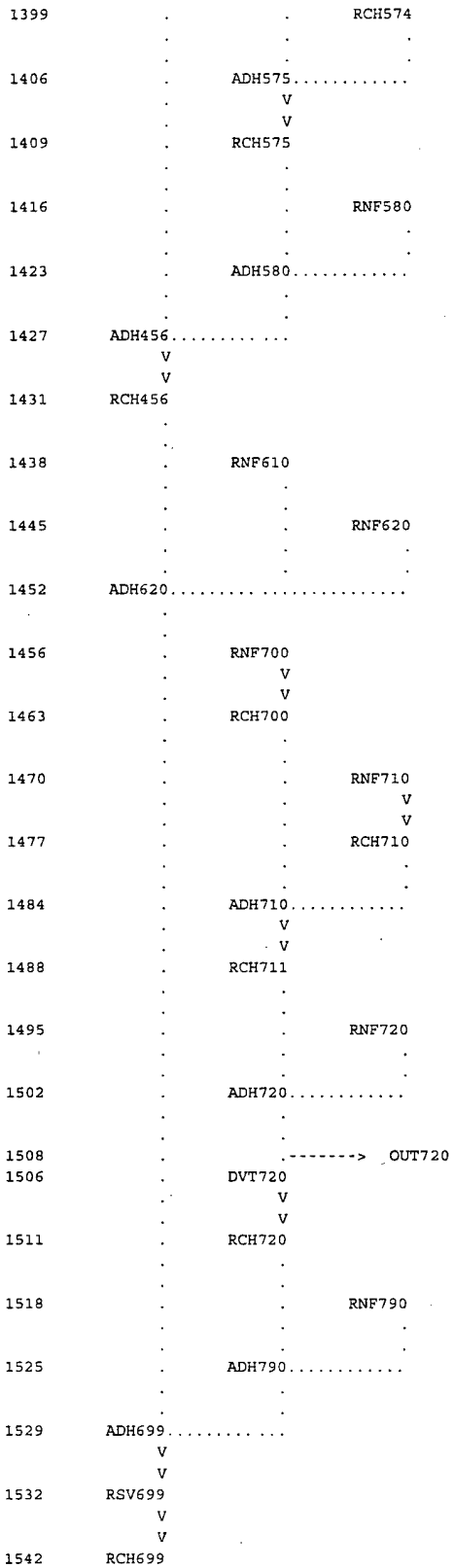
V
V
1391 RCH571
1396 ADH574
V
V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1456 RNF700
1463 RCH700
1470 RNF710
1477 RCH710
1484 ADH710
1488 RCH711
1495 RNF720
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1525 ADH790
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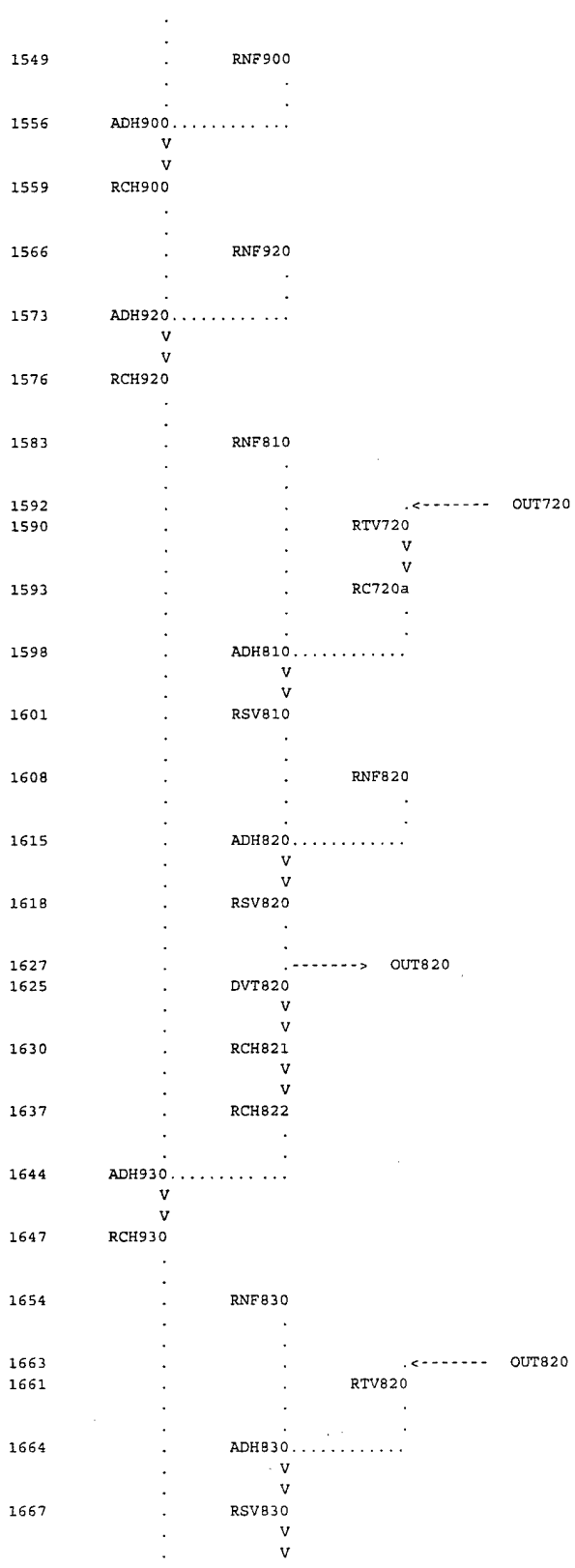
1542 RCH699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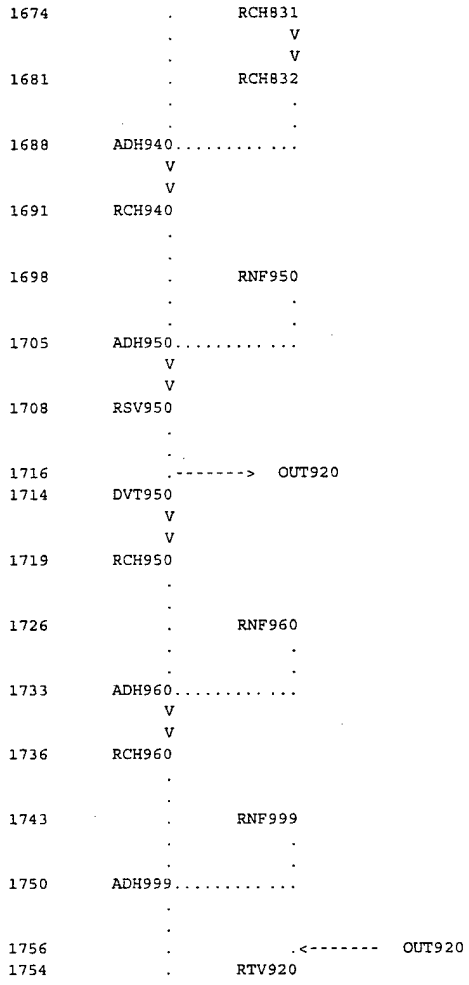
1593 RC720a
1598 ADH810
1601 RSV810
1608 RNF820
1615 ADH820
1618 RSV820
1627 OUT820
1625 DVT820
1630 RCH821
1637 RCH822
1644 ADH930
1647 RCH930
1654 RNF830
1663 OUT820
1661 RTV820
1664 ADH830
1667 RSV830


1674
RCH831
1681
RCH832
1688
ADH940
1691
RCH940
1698
RNF950
1705
ADH950
1708
RSV950
1716
OUT920
1714
DVT950
1719
RCH950
1726
RNF960
1733
ADH960
1736
RCH960
1743
RNF999
1750
ADH999
1756
OUT920
1754
RTV920

Appendix B

HEC-1 Input
Spring Runoff Events

```
ID       Roseau River Watershed District
ID       Developed by JOR Engineering, Inc. Crookston, MN
ID       10 Day Spring Event 6/11/01 Michael Bakken
*DIAGRAM
IT   480  1JAN94       0     150
IO     0
KK  RNF9
KM    Local Drainage to Roseau River Flowage
KO     0       0       0       0      22
BA 40.81
IN  144.
KM      100 year
PB   6.1
KM    50 year
PB  5.49
KM    25 year
PB  4.88
KM    10 year
PB  4.03
PC    0. 0.00527 0.01059 0.01596 0.02139 0.02687 0.03241 0.03801 0.04368 0.04941
PC0.0552 0.06108 0.06702 0.07304 0.07914 0.08532 0.09158 0.09793 0.10438 0.11092
PC0.1175 0.12432 0.13119 0.13818 0.14529 0.15253 0.15991 0.16744 0.17513 0.183
PC0.191  0.1993  0.20776 0.21645 0.22539 0.23460 0.24412 0.25397 0.2642  0.27485
PC0.2859 0.29769 0.31004 0.32318 0.33728 0.35261 0.36957 0.38885 0.41184 0.44238
PC0.5323 0.57169 0.59764 0.61852 0.63652 0.6526  0.66728 0.68088 0.69361 0.70562
PC0.717  0.72792 0.73836 0.7484  0.75808 0.76744 0.77651 0.78532 0.79389 0.80224
PC0.8103 0.81834 0.82612 0.83373 0.84119 0.8485  0.85568 0.86273 0.86965 0.87646
PC0.8831 0.88975 0.89624 0.90264 0.90895 0.91517 0.92131 0.92737 0.93335 0.93925
PC0.945  0.95084 0.95654 0.96217 0.96774 0.97325 0.97871 0.98411 0.98947 0.99474
LS     0     100       0
UC 35.53   82.78
* fan
UA     0    0.05    0.15    0.35    0.65       1
KK  RSV9
KM     Roseau River Flowage Impoundment
KM      Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO     0       0       0       0      22
RS     1    STOR     240       0
* rsv9stor
SV   240     310     400     500     643     940    1092    1245    1550
* rsv9flow
SQ     0      52     155     288     435     800    1225    1913    3663
* Rsv9elev
SE  1230  1230.5    1231  1231.5    1232    1233  1233.5    1234    1235
KK  RCH9
KM     North Branch Downstream of Roseau River Flowage
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   11200  0.0004       0
* rch9
RX     0     700     750     756     780     786     900    2800
RY  1230    1225    1224    1218    1218    1224    1225    1230
KK RNF15
KM    local drainage to DNR dam 3 Non-functional
KO     0       0       0       0      22
BA 13.69
LS     0     100       0
UC 25.65    51.3
* diamond
UA     0    0.09    0.34    0.64     0.9       1
KK ADH15
KO     0       0       0       0      22
HC     2
KK RCH15
KM     North Branch Downstream of DNR dam 3
```

```
KO      0       0       0       0       22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   12800  0.0004       0
* rch15
RX      0     820    1000    1006    1030    1036    1400    2500
RY   1225    1220    1219    1213    1213    1219    1220    1225
KK RNF19
KM    Local Drainage to DNR dam 4 Non-functional
KO      0       0       0       0       22
BA   5.8
LS      0     100       0
UC 14.88   29.76
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH19
KO      0       0       0       0       22
HC      2
KKRCH19a
KM    North Branch downstream of DNR dam 4
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    9400  0.0011       0
* rch19a
RX      0     510     690     696     720     726     990    1690
RY   1225    1220    1209    1203    1203    1209    1220    1225
KK RC19b
KM    North Branch downstream of DNR dam 4
KO      0       0       0       0       22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   26000  0.0012       0
* rch19b
RX      0     200     280     286     318     324     390     450
RY   1210    1200    1195  1188.5  1188.5    1195    1200    1210
KK RNF25
KM    Local drainage to North Branch at Hanson Creek
KO      0       0       0       0       22
BA 12.52
LS      0     100       0
UC   18.8    37.6
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KK ADH25
KM     North Branch Upstream of Hanson Creek
KO      0       0       0       0       22
HC      2
KK RNF29
KM    DNR dam 1 on Hanson Creek
KO      0       0       0       0       22
BA 12.73
LS      0     100       0
UC 34.28   79.87
* fan
UA      0    0.05    0.15    0.35    0.65       1
KK RSV29
KM    DNR dam 1 on Hanson Creek
KM     Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0       0       0       0       22
RS      1    STOR     320       0
* rsv29stor
SV   320     370     450     650     670     810     960    1360
* rsv29flow
SQ      0    57.5     166     319     558     934    1310    4235
* rsv29elev
SE   1219  1219.5    1220  1220.5    1221  1221.5    1222    1223
KK RCH29
```

```
KM    Hanson Creek downstream of DNR dam 1
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125    0.035    0.125     6000   0.0009        0
* rch29
RX      0      400      800      803      818      821     1100     1480
RY   1220     1215     1214     1211     1211     1214     1215     1220
KK RNF35
KM    Non-functional DNR dam 2 on Hanson Creek
KO      0        0        0        0       22
BA   4.9
LS      0      100        0
UC 22.66     52.8
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KK ADH35
KO      0        0        0        0       22
HC      2
KK RCH35
KM    Hanson Creek from DNR dam 2 to Winner Dam
KO      0        0        0        0       22
RS      5     FLOW        0        0
RC 0.125    0.035    0.125    17000   0.0006        0
*  rch35
RX      0      110      310      316      336      342      600     1000
RY   1210     1205     1204     1198     1198     1204     1205     1210
KK RNF39
KM     Local drainage to Winner Dam
KO      0        0        0        0       22
BA 13.36
LS      0      100        0
UC 40.79    95.04
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KK ADH39
KO      0        0        0        0       22
HC      2
KK RSV39
KM    Winner Dam impoundment on Hanson Creek
KM     Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0        0        0        0       22
RS      1     STOR        5        0
* rsv39stor
SV      5       21       30       65      120      220      370      470      580
* rsv39flow
SQ      0        6       32       75      170      320      560      920     1500
* rsv39elev
SE1201.5     1202     1203     1204     1205     1206     1207   1207.5     1208
KK RCH39
KM     Hanson Creek Winner dam to North Branch
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    20500   0.0013        0
* rch39
RX      0      700      990      996     1036     1042     1290     1680
RY   1205     1200     1194     1182     1182     1194     1200     1205
KK RNF45
KM    Local drainage to outlet of Hanson Creek
KO      0        0        0        0       22
BA  5.59
LS      0      100        0
UC 16.96    33.92
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KK ADH45
```

```
KM    Hanson Creek outflow
KO      0       0       0       0      22
HC      2
KK ADH46
KO      0       0       0       0      22
HC      2
KK RCH46
KM    North Branch from Hanson Creek to Hayes Lake
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   11000  0.0007       0
* rch46
RX      0     200     350     358     390     398     460     990
RY   1190    1175    1169    1161    1161    1169    1175    1190
KK RNF49
KM    Local drainage to Hayes Lake
KO      0       0       0       0      22
BA 18.29
LS      0     100       0
UC 60.89  121.78
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH49
KO      0       0       0       0      22
HC      2
KK RSV49
KM    Hayes Lake Dam
KM      Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0       0       0       0      22
RS      1    STOR    1640       0
* rsv49stor
SV      0     180     595    1290    1640    1680    1750    1840    2050    2270
SV   2510    2760    3000    3070    3180    3250
* rsv49flow
SQ      0       0       0       0       0      19      72     213     640    1235
SQ   2000    2950    4060    4610    5140    8150
* rsv49elev
SE   1150    1155    1160    1165    1167  1167.2  1167.5    1168    1169    1170
SE   1171    1172    1173  1173.4  1173.7    1174
KK RCH49
KM    North Branch Hayes Lake to Beaver
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   28200   0.001       0
* rch49
RX      0      90     160     168     228     236     690     800
RY   1150    1135    1130    1122    1122    1130    1135    1150
KK RNF59
KM    Local Drainage to Beaver
KO      0       0       0       0      22
BA 15.71
LS      0     100       0
UC 43.26   64.89
* fan
UA      0    0.05    0.15    0.35    0.65       1
KK ADH59
KO      0       0       0       0      22
HC      2
KK RCH59
KM     North Branch to Pencer
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   38000  0.0009       0
* rch59
RX      0     110    1000    1008    1068    1072    1690    1770
```

```
RY  1125    1120    1115    1107    1107    1115    1120    1125
KK RNF65
KM    Local drainage to Pencer East
KO     0       0       0       0      22
BA 12.79
LS     0     100       0
UC 15.54   12.43
* fan
UA     0    0.05    0.15    0.35    0.65       1
KK ADH65
KO     0       0       0       0      22
HC     2
KK RCH65
KM    North Branch to Severson Creek
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   25509  0.0008       0
*  rch65
RX     0      80     250     270     330     350    1580    1680
RY  1095    1090    1085    1075    1075    1085    1090    1095
KK RNF69
KM    Local drainage to North Branch at Severson Creek
KO     0       0       0       0      22
BA  2.29
LS     0     100       0
UC  7.24    7.24
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KK ADH69
KO     0       0       0       0      22
HC    2.
KKRNF070
KM    Severson Creek
KO     0       0       0       0      22
BA 22.25
LS     0     100       0
UC  17.3    17.3
* fan
UA     0    0.05    0.15    0.35    0.65       1
KK ADH70
KO     0       0       0       0      22
HC     2
KKRCH070
KM    North Branch to Bear Creek
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   29973  0.0008       0
*  rch70
RX     0      80     250     270     330     350    1580    1680
RY  1085    1080    1075    1065    1065    1075    1080    1085
KKRNF079
KM     Local drainage North Branch at Bear Creek
KO     0       0       0       0      22
BA  7.52
LS     0     100       0
UC 13.14   13.14
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KK ADH79
KO     0       0       0       0      22
HC     2
KK RNF80
KM    Local Drainage Comstocks  Bear Creek at Roseau CSAH 9
KO     0       0       0       0      22
BA 20.66
```

```
LS      0      100        0
UC  16.8    14.11
* fan
UA      0     0.05     0.15     0.35     0.65        1
KK RCH80
KM     Bear Creek Comstock to North Branch
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    28200   0.0008        0
*  rch80
RX      0      180      400      406      456      462      640      820
RY   1080     1075     1070     1064     1064     1070     1075     1080
KK RNF85
KM     Local drainage Bear Creek at outlet
KO      0        0        0        0       22
BA   5.27
LS      0      100        0
UC 11.08     8.64
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KK ADH85
KM     Bear Creek at North Branch
KO      0        0        0        0       22
HC      2
KK ADH86
KO      0        0        0        0       22
HC      2
KK RCH86
KM     North Branch from Bear Creek to Malung
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    20800   0.0006        0
*  rch86
RX      0      260      350      354      411      415      490      710
RY   1070     1055     1054     1050     1050     1054     1055     1070
KK RNF99
KM     Local Drainage to Gage 2
KO      0        0        0        0       22
BA   2.18
LS      0      100        0
UC   3.96     2.65
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KK ADH99
KO      0        0        0        0       22
HC      2
KKRSV99
KM temporary calibration reservoir
RS      1     STOR        0
*  rsv99stor
SV      0      800     1200     4800     6500     7000     7300     7400     7800     8000
*  rsv99flow
SQ      0      100      200      500     1000     1500     2500     3000     5000    15000
KK RCH99    CNAME       G2
KM     North Branch gage 2 to South Branch
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    17800   0.0004        0
*  rch99
RX      0      110      180      186      246      252      260      810
RY   1055     1050     1044     1038     1038     1044     1050     1055
KKRNF109
KM     Local drainage South Branch at Skime
KO      0        0        0        0       22
BA 28.21
```

```
LS      0      100        0
UC 67.63   157.58
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH109
KM     South Branch Skime to Casperson
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125    0.035    0.125    34800   0.0007        0
*  rch109
RX      0     1400     1620     1624     1664     1668     2150     3220
RY   1175     1170     1165     1161     1161     1165     1170     1175
KKRCH110
KM     South Branch Casperson to Mickinock Creek
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    35000   0.0012        0
*  rch110
RX      0      280      300      305      345      349      400      540
RY   1135     1130     1125     1120     1120     1125     1130     1135
KKRNF119
KM     Local drainage to South Branch at Mickinock Creek
KO      0        0        0        0       22
BA   24.2
LS      0      100        0
UC 25.87    51.74
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH119
KM     Combined flow South Branch upstream of Mickinock Creek
KO      0        0        0        0       22
HC      2
KKRNF120
KM      Palmville sub RNF3
KM     Palmville sub refers to areas developed for the Palmville Flood Control P
KO      0        0        0        0       22
BA   1.27
LS      0      100        0
UC   7.06    14.12
* fan
UA      0     0.05     0.15     0.35       65        1
KKRCH120
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     5500   0.0018        0
*  rch120
RX      0       10       20      500      800     1300     1310     1320
RY   1170     1169   1168.5     1168     1168   1168.5     1169     1170
KKRNF121
KM     Palmville sub RNF4b
KO      0        0        0        0       22
BA   0.95
LS      0      100        0
UC   9.62    19.24
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH121
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     5500   0.0009        0
*  rch121
RX      0       10       20      500      800     1300     1310     1320
RY   1172     1171   1170.5     1170     1170   1170.5     1171     1172
KKRNF123
KM     Palmville sub RNF4a
```

```
KO      0       0       0       0       22
BA  2.32
LS      0     100       0
UC  6.98   13.96
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH123
KO      0       0       0       0       22
HC      2
KKRCH123
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC  0.15    0.15    0.15    2500   0.004       0
*  rch120
RX      0      10      20     500     800    1300    1310    1320
RY   1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKADH124
KO      0       0       0       0       22
HC      2
KKRNF125
KM      Palmville sub RNF5
KO      0       0       0       0       22
BA  4.44
LS      0     100       0
UC  15.4    30.8
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH125
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC  0.15    0.15    0.15    1500  0.0033       0
*  rch120
RX      0      10      20     500     800    1300    1310    1320
RY   1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF126
KM      Palmville sub RNF6
KO      0       0       0       0       22
BA  1.25
LS      0     100       0
UC 11.52   17.28
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH126
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC  0.15    0.15    0.15    8000  0.0006       0
*  rch120
RX      0      10      20     500     800    1300    1310    1320
RY   1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF127
KM      Palmville sub RNF7
KO      0       0       0       0       22
BA  2.93
LS      0     100       0
UC 16.27   16.27
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KKRCH127
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC  0.15    0.15    0.15    9000  0.0006       0
*  rch120
RX      0      10      20     500     800    1300    1310    1320
RY   1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF128
```

```
KM     Palmville sub RNF8
KO     0       0       0       0      22
BA  1.22
LS     0     100       0
UC  6.25    9.38
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRCH128
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.15    0.15    6000  0.0008       0
*  rch120
RX     0      10      20     500     800    1300    1310    1320
RY  1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF129
KM     Palmville sub RNF9
KO     0       0       0       0      22
BA   2.9
LS     0     100       0
UC  7.84   11.76
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF130
KM     Palmville sub RNF10
KO     0       0       0       0      22
BA  1.29
LS     0     100       0
UC  5.11   11.91
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH130
KO     0       0       0       0      22
HC     7
KKRNF131
KM     Palmville wildlife pool
KO     0       0       0       0      22
BA  7.65
LS     0     100       0
UC 13.89   32.36
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH131
KO     0       0       0       0      22
HC     2
KKRNF132
KM     Palmville Flood Pool
KO     0       0       0       0      22
BA  0.89
LS     0     100       0
UC  7.85   18.29
* diamond
UA     0    0.09    0.34    0.64     0.9       1
KKADH132
KO     0       0       0       0      22
HC     2
KKRCH132
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.05    0.15   10560  0.0005       0
*  rch132
RX     0       4       6      16      24      34    1320    1325
RY  1153    1151    1149    1144    1144    1149    1150    1152
KKRCH133
KO     0       0       0       0      22
RS     1    FLOW       0       0
```

```
RC  0.15    0.05    0.15    9200  0.0016       0
*  rch133
RX     0       4       6      22      30      46    1320    1325
RY  1148    1146    1144    1136    1136    1144    1144    1146
KKRNF139
KM     Local drainage to Oseland Gage
KO     0       0       0       0      22
BA 23.74
LS     0     100       0
UC  21.3   31.95
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH139
KO     0       0       0       0      22
HC     2
KKRCH139
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125   14800  0.0006       0
*  rch139
RX     0     140     200     204     224     228     305     350
RY  1127    1120    1119    1115    1115    1119    1120    1127
KKRNF145
KM    Local drainage to Mickinock Creek at Outlet
KO     0       0       0       0      22
BA  8.37
LS     0     100       0
UC 18.97   18.97
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH145
KM    Mickinock Creek
KO     0       0       0       0      22
HC     2
KKADH146
KO     0       0       0       0      22
HC     2
KKRCH146
KM     South Branch Mickinock Creek to Wannaska
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   26600  0.0009       0
*  rch146
RX     0      90     120     127     167     174     305     390
RY  1110    1105    1100    1093    1093    1100    1105    1110
KKRNF149
KM    Local drainage South Branch at Wannaska
KO     0       0       0       0      22
BA    14
LS     0     100       0
UC 19.28   19.28
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH149
KO     0       0       0       0      22
HC     2
KKRCH149
KM     South Branch Wannaska to Paulson Creek
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   15200  0.0004       0
*  rch149
RX     0     175     300     306     346     352     775     800
RY  1100    1095    1090    1084    1084    1090    1095    1100
KKRNF155
```

```
KM     Local drainage South Branch at Paulson Creek
KO     0       0       0       0       22
BA  4.45
LS     0     100       0
UC  6.05    4.05
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH155
KO     0       0       0       0       22
HC     2
KKRNF159
KM     Local drainage gage 43  Roseau CD 21 at CSAH4
KO     0       0       0       0       22
BA 20.07
LS     0     100       0
UC 20.56   27.76
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRCH159
KO     0       0       0       0       22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    8500  0.0005       0
*  rch159
RX     0     7.5      15      30      38      53    1373    2700
RY  1125  1122.5    1120    1115    1115    1120  1122.5    1125
KKRCH160
KO     0       0       0       0       22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    4400  0.0036       0
*  rch160
RX     0     150     180     185     195     200     300     400
RY  1115    1100    1095    1090    1090    1095    1100    1115
KKRNF165
KM     Local Drainage Paulson Creek at Outlet
KO     0       0       0       0       22
BA  3.47
LS     0     100       0
UC 10.25   10.25
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH165
KM    Combined outflow Paulson Creek
KO     0       0       0       0       22
HC     2
KKADH166
KO     0       0       0       0       22
HC     2
KKRCH166
KM     South Branch Paulson Creek to Pencer West
KO     0       0       0       0       22
RS     2    FLOW       0       0
RC 0.125   0.035   0.125   29800  0.0004       0
*  rch166
RX     0     160     500     520     580     600     650     700
RY  1090    1080    1080    1070    1070    1080    1085    1090
KKRNF169
KM    Local Drainage to Pencer West
KO     0       0       0       0       22
BA  6.56
LS     0     100       0
UC 14.79   14.79
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH169
KO     0       0       0       0       22
```

```
HC     2
KKRCH169
KM    South Branch Pencer West to Unamed Creek 1
KO     0       0       0       0       22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   17000  0.0005       0
*  rch169
RX     0      90     690     712     752     774     800     850
RY  1075    1070    1065    1054    1054    1065    1070    1075
KKRNF170
KM    Local draiange South Branch at Unamed Creek 1
KO     0       0       0       0       22
BA  1.65
LS     0     100       0
UC  6.34    6.34
*  general
UA     0    0.13    0.36    0.67    0.89       1
KKADH170
KM    South Branch upstream Unamed Creek 1
KO     0       0       0       0       22
HC     2
KKRNF171
KM    Local Drainage Unamed Creek 1
KO     0       0       0       0       22
BA 13.67
LS     0     100       0
UC 19.15   19.15
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH171
KO     0       0       0       0       22
HC     2
KKRCH171
KM    South Branch Unamed Creek 1 to Unamed Creek 2
KO     0       0       0       0       22
RS     3    FLOW       0       0
RC 0.125   0.035   0.125   34400  0.0005       0
*  rch171
RX     0      90     690     712     752     774     800     850
RY  1070    1065    1060    1049    1049    1060    1065    1070
KKRNF172
KM    Local drainage South Branch at Unamed Creek 2
KO     0       0       0       0       22
BA  5.04
LS     0     100       0
UC 16.23   16.23
* diamond
UA     0    0.09    0.34    0.64     0.9       1
KKADH172
KM    South Branch upstream Unamed Creek 2
KO     0       0       0       0       22
HC     2
KKRNF173
KM    Local drainage Unamed Creek 2
KO     0       0       0       0       22
BA 16.03
LS     0     100       0
UC 16.17   16.17
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH173
KO     0       0       0       0       22
HC     2
KKRCH173
KM    South Branch Unamed Creek 2 to Gage 1
```

```
KO      0       0       0       0       22
RS      3     FLOW      0       0
RC 0.125    0.035   0.125   27000  0.0005       0
*  rch173
RX      0      90     690     712     752     774     800     850
RY   1065    1060    1055    1044    1044    1055    1060    1065
KKRNF199
KM     Local drainage to Gage 1
KO      0       0       0       0       22
BA   9.25
LS      0     100       0
UC 11.09   11.09
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH198
KO      0       0       0       0       22
HC      2
KKRNF180
KM     Local drainage gage 3 Sec 18/19 T161N R39W
KO      0       0       0       0       22
BA 11.52
LS      0     100       0
UC 18.81   18.81
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH180
KM      Sucker Creek Gage 1 to Outlet
KO      0       0       0       0       22
RS      1     FLOW      0       0
RC 0.125    0.05   0.125    9000  0.0023       0
*  rch180
RX      0      90     100     125     130     155     180     240
RY   1060    1050    1044    1041    1041    1044    1050    1060
KKRNF189
KM     Local drainage outlet Sucker Creek
KO      0       0       0       0       22
BA   0.69
LS      0     100       0
UC  7.44    4.98
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH189
KM     Sucker Creek Outflow
KO      0       0       0       0       22
HC      2
KKADH199
KO      0       0       0       0       22
HC      2
KKRSV199
KM temporary calibration reservoir
RS      1     STOR      0
*  rsv199stor
SV      0     800    1200    4800    6500    7000    7300    7400    7800    8000
*  rsv199flow
SQ      0     100     200     500    1000    1500    2500    3000    5000   15000
KKRCH199
KM     South Branch to North Branch
KO      0       0       0       0       22
RS      1     FLOW      0       0
RC 0.125   0.035   0.125    6000  0.0005       0
*  rch199
RX      0      90     100     106     146     152     290    1200
RY   1055    1040    1039    1033    1033    1039    1050    1055
KKADH200
KO      0       0       0       0       22
```

```
HC     2
KKRCH200
KM    Roseau River to USGS Gage near Malung
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125    2400  0.0003       0
*  rch200
RX     0     400     435     443     493     501     600    1600
RY  1055    1045    1040    1034    1034    1040    1050    1055
KKRNF209
KM    Local drainage to USGS Gage near Malung  Gage 50
KO     0       0       0       0      22
BA  3.24
LS     0     100       0
UC  8.83    8.83
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH209
KO     0       0       0       0      22
HC     2
KKRCH209
KM    Roseau River gage 50 to CD 8
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125    1000  0.0003       0
*  rch200
RX     0     400     435     443     493     501     600    1600
RY  1055    1045    1040    1034    1034    1040    1050    1055
KKRNF211
KM    Local Drainage to Stafford area 1
KO     0       0       0       0      22
BA 11.25
LS     0     100       0
UC  16.8   11.25
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF212
KM    Local drainage to Stafford area 2
KO     0       0       0       0      22
BA  1.45
LS     0     100       0
UC  2.49    1.67
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF213
KM    Local drainage to Stafford area 3
KO     0       0       0       0      22
BA   0.7
LS     0     100       0
UC  5.56    3.73
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH211
KO     0       0       0       0      22
HC     3
KKRCH211
KM    Roseau County Ditch 8 Stafford project to Outlet
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125   17120  0.0005       0
*  rch211
RX     0      10      16      31      37      52    1372    2640
RY1058.2    1058    1056    1051    1051    1056  1056.2  1056.5
KKRNF219
KM    Local Drainage Outlet RCD 8
```

```
KO      0       0       0       0       22
BA  6.26
LS      0     100       0
UC 17.92   17.92
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH220
KM    Roseau County ditch 8 outflow
KO      0       0       0       0       22
HC      2
KKADH221
KO      0       0       0       0       22
HC      2
KKRCH221
KM    Roseau River RCD 8 to Cow Creek
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    8800  0.0003       0
*  rch221
RX      0    3600    3800    3812    3862    3874    4024    7624
RY  1055    1050    1035    1029    1029    1035    1050    1055
KKRNF229
KM    Local drainage Roseau River at Cow Creek
KO      0       0       0       0       22
BA  4.83
LS      0     100       0
UC 12.04   12.04
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH229
KM    Roseau River upstream Cow Creek
KO      0       0       0       0       22
HC      2
KKRNF248
KM    Local drainage Cow Creek Gage 44 Sec 31/32 T162N R39W
KO      0       0       0       0       22
BA  16.9
LS      0     100       0
UC 15.15   15.15
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH248
KM    Cow Creek Gage 44 to Outlet
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    4800  0.0023       0
*  rch248
RX      0     170     190     194     204     208     290     380
RY  1050    1045    1044    1040    1040    1044    1045    1050
KKRNF249
KM    Local drainage outlet Cow Creek
KO      0       0       0       0       22
BA  0.31
LS      0     100       0
UC  1.76    1.76
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH249
KM    Cow Creek Outflow
KO      0       0       0       0       22
HC      2
KKADH260
KO      0       0       0       0       22
HC      2
KKRCH260
```

```
KM    Roseau River Cow Creek to Center Street
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   11800  0.0003       0
*  rch221
RX      0    3600    3800    3812    3862    3874    4024    7624
RY   1055    1050    1035    1029    1029    1035    1050    1055
KKRNF269
KM    Local drainage Roseau River at Center Street
KO      0       0       0       0      22
BA   5.07
LS      0     100       0
UC 10.04   10.04
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH269
KO      0       0       0       0      22
HC      2
KKRCH269
KM    Roseau River Center Street to Gage 15
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   23500  0.0003       0
*  rch269
RX 11097   13712   20000   20035   20106   20131   20219   23721
RY1043.9  1038.4  1041.3  1024.7  1024.7  1036.8  1035.1  1043.6
KKRNF299
KM    Local drainage Roseau River Gage 15
KO      0       0       0       0      22
BA   5.51
LS      0     100       0
UC  9.18    9.18
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KKADH299
KO      0       0       0       0      22
HC      2
KKRNF319
KM    Local Drainage Hay Creek at County Road 2 Sec 1/12 T161N R37W
KO      0       0       0       0      22
BA 19.38
LS      0     100       0
UC 17.12   16.95
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH319
KM    Hay Creek County Road 2 to Branch CD 9
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    7200  0.0017       0
*  rch319
RX      0    1130    1270    1282    1300    1312    1400    1650
RY   1110    1105    1095    1089    1089    1095    1105    1110
KKRNF335
KM    Upper Summer Road RCD 9 drainage
KO      0       0       0       0      22
BA 10.04
LS      0     100       0
UC 19.28   19.28
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKDVT335
KM    Split flow west to Summer Road
DTOUT335        0       0
*  din335
```

```
DI     0      50     100     200     300     500     750    1000
*  dout335
DQ     0      33      67     133     200     333     500     670
KKRCH335
KM    Branch of RCD 9 west to Hay Creek
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    8810  0.0005       0
*  rch335
RX     0     800    1700    1708    1712    1720    1722    1724
RY  1110    1107    1105    1101    1101    1105    1106    1107
KKADH336
KO     0       0       0       0      22
HC     2
KKRCH336
KM    Hay Creek branch RCD9 to Summer Road
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    7800  0.0017       0
*  rch336
RX     0    1130    1270    1282    1300    1312    1400    1650
RY  1105    1100    1090    1084    1084    1090    1100    1105
KKRNF339
KM    Local Drainage Hay Creek at Summer Road
KO     0       0       0       0      22
BA  10.5
LS     0     100       0
UC  17.2    17.2
*  fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH339
KO     0       0       0       0      22
HC     2
KKRCH339
KM    Hay Creek Summer Road to Branch of RCD 9
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    4400   0.001       0
*  rch339
RX     0     100    3550    3562    3580    3592    4000    4800
RY  1080    1078    1075    1069    1069    1075    1078    1080
KKRNF351
KM    Local drainage Upper Hwy 11
KO     0       0       0       0      22
BA  4.32
LS     0     100       0
UC 12.99   12.99
*  fan
UA     0    0.05    0.15    0.35    0.65       1
KKRTV335
KM    Split flow from Upper Summer Road North
DROUT335
KKRCH350
RS     2    FLOW       0       0
RC 0.125    0.05   0.125   10560  0.0014       0
*  rch350
RX     0       2       4      12      16      24    1320    2640
RY  1107    1106    1105    1101    1101    1105  1105.5    1107
KKADH351
KO     0       0       0       0      22
HC     2
KKDVT351
KM Split flow to Roseau County Road 11
DTOUT351
*  din351
```

```
DI    0.    100.    200.    400.    600.    800.   1000.   2000.
*  dout351
DQ    0.     50.    100.    200.    300.    400.    500.   1000.
KKRCH351
KM    Branch RCD 9 to Hay Creek
KO     0       0       0       0      22
RS     3    FLOW       0       0
RC 0.125    0.05   0.125   16600  0.0007       0
*  rch351
RX     0     750    1320    1328    1332    1340    1342    1344
RY  1090    1089    1088    1084    1084    1088    1090    1092
KKADH352
KO     0       0       0       0      22
HC     2
KKRCH352
KM    Hay Creek branch of RCD9 to Gage 12
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    7400  0.0014       0
*  rch352
RX     0     100    3550    3562    3580    3592    4000    4800
RY  1075    1073    1070    1064    1064    1070    1073    1075
KKRNF359
KM    Local drainage Hay Creek at Gage 12
KO     0       0       0       0      22
BA 12.44
LS     0     100       0
UC 13.97   14.39
*  diamond
UA     0    0.09    0.34    0.64     0.9       1
KKADH359
KO     0       0       0       0      22
HC     2
KKRCH359
KM    Hay Creek Gage 12 to Branch RCD 9
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    9220  0.0009       0
*  rch359
RX     0     250     550     562     580     592     700    1000
RY  1070    1068    1065    1059    1059    1065    1068    1070
KKRTV351
KM    Upper Hwy 11 split flow
DROUT351
KKRCH352
RS     4    FLOW       0       0
RC 0.125    0.05   0.125   37920  0.0007       0
*  rch352
RX     0       2       4      12      16      24     500    1000
RY  1076    1075    1074    1070    1070    1074    1074    1075
KKADH360
KO     0       0       0       0      22
HC     2
KKRCH360
KM    Hay Creek Branch RCD9 to MN HWY 11
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    4980  0.0009       0
*  rch360
RX     0     250     550     562     580     592     700    1000
RY  1060    1058    1055    1049    1049    1055    1058    1060
KKRNF379
KM    Local Drainage MN Hwy 11
KO     0       0       0       0      22
BA 20.97
```

```
LS      0     100       0
UC  37.8    56.7
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH379
KO      0       0       0       0      22
HC      2
KKRCH379
KM    Hay Creek MN Hwy 11 to Hay Creek Proj Det 1
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    5680  0.0004       0
*  rch379
RX      0    1000    2300    2312    2328    2340    4000    5000
RY  1060    1058    1058    1050    1050    1058    1058    1060
KKRNF381
KM    Hay Creek Proj Det 1
KO      0       0       0       0      22
BA  4.14
LS      0     100       0
UC 20.23   20.23
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH381
KO      0       0       0       0      22
HC      2
KKRCH381
KM    Hay Creek Det 1 to Roseau County Ditch 18
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   10820  0.0004       0
*  rch381
RX      0    1000    2300    2312    2328    2340    4000    5000
RY  1055    1053    1053    1045    1045    1053    1053    1055
KKRNF385
KM    Norland sub RNF50 Roseau County Ditch 18  Sec 4/5 T162N R38W
KO      0       0       0       0      22
BA  8.39
LS      0     100       0
UC 29.83   59.66
*  rnf385
UA      0     0.1    0.24    0.46    0.65    0.75    0.83    0.89    0.94    0.98
UA      1
KKRCH385
KM    RCD 18 to Hay Creek
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08   17690   0.001       0
*  rch385
RX      0       5      10      45      53      57     100     250
RY1067.4  1067.4  1067.4 1056.14 1056.14  1064.7  1064.7  1064.7
KKRNF391
KM    Hay Creek Project Pool #1
KO      0       0       0       0      22
BA  2.21
LS      0     100       0
UC   3.6     3.6
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH391
KO      0       0       0       0      22
HC      2
KKRCH391   CNAME     391
KM    RCD 18 Pool#1 to NW Sec 2 T162N R39W
KO      0       0       0       0      22
```

```
RS     1    FLOW       0       0
RC  0.08    0.05    0.08    5280  0.0003       0
*  rch391
RX     0       5      10      24      30      44    5000    5250
RY  1053    1052    1049    1042    1042    1049  1049.5    1050
KKDVT391
KM Split flow RCD 18
DTOUT391
*  in391
DI    0.    300.    600.    900.   1200.   2100.
*  out391
DQ    0.    200.    400.    600.    800.   1400.
KKRCH392
KM    RCD 18 NW Sec 2 T162N R39W
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.08    0.05    0.08    8300  0.0003       0
*  rch392
RX     0       5      10      24      30      44    5000    5250
RY  1052    1051    1048    1041    1041    1048  1048.5    1049
KKADH395
KO     0       0       0       0      22
HC     2
KKRCH395
KM    Hay Creek RCD 18 to Outlet
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   12900  0.0004       0
*  rch395
RX     0    1000    2300    2312    2328    2340    4000    5000
RY  1050    1048    1048    1040    1040    1048    1048    1050
KKRNF399
KM    Local drainage to Lower Hay Creek
KO     0       0       0       0      22
BA 19.76
LS     0     100       0
UC  24.8      31
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH399
KM    Hay Creek at Outlet
KO     0       0       0       0      22
HC     2
KKADH400
KM Roseau River at Gage 15 Sec 6/31 T162-163N R39W County Road 28
KO     0       0       0       0      22
HC    2.
KKRSV400
KM Storage behind CR 28
KO     0       0       0       0      22
RS     1    FLOW       0
*  rsv400stor
SV     0     147     247     847    2587    4517    7282   10872   15272   20471
*  rsv400flow
SQ     0     720     800    2190    4110    5200    6120    8450   10000   11690
KKRTV391
KM    Overflow RCD 18
DROUT391
KKRC391b
RS     1    FLOW       0       0
RC  0.08    0.05    0.08   17000  0.0006       0
*  rc391b
RX     0       2       4      14      18      28    1300    2600
RY  1057    1056    1055    1050    1050    1055  1055.5    1057
KKADH401
```

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KM    Roseau River at Sout side Sec 31 T163N R39W at lateral JD61
KO      0       0       0       0      22
HC      2
KKRC391m
KM    Roseau River Gage 15 to Lat 3 Judicial 61
KO      0       0       0       0      22
RS      1    STOR       0       0
*  stor391m
SV      0      90     132     228     606    2187    2916    3579    4242    5460
*  flow391m
SQ      0     500    1000    2000    3000    5000    6000    7000    8000   10000
KKRNF401
KM    Norland sub RNF20 Sec 28/29 T163N R37W
KO      0       0       0       0      22
BA   2.85
LS      0     100       0
UC   6.27    9.41
*  rnf401
UA      0       0    0.01    0.03    0.09    0.19    0.29    0.51    0.78    0.95
UA      1
KKRCH401
KM    Lat 3 JD61
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC   0.08    0.05    0.08    5120   0.006       0
*  rch401
RX      0       5      10      19      27      36     143     243
RY1079.1    1079    1078    1075    1075    1078    1079  1079.1
KKRNF402
KM    Norland Sub RNF30
KO      0       0       0       0      22
BA   6.43
LS      0     100       0
UC  39.75    79.5
*  rnf402
UA      0    0.19    0.33    0.56    0.79    0.87    0.92    0.93    0.95    0.99
UA      1
KKADH402
KO      0       0       0       0      22
HC      2
KKDVT402
KM 50-50 split west and north
DTOUT402
*  in402
DI     0.      10.     20.     30.     40.     50.    100.    200.    500.   1000.
*  out402
DQ     0.       5.     10.     15.     20.     25.     50.    100.    250.    500.
KKRCH402
KM    Lat 3 JD61
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC   0.08    0.05    0.08   10320   0.006       0
*  rch402
RX      0       5      10      22      30      42      47     252
RY1075.1    1075    1074    1070    1070    1074    1075  1075.1
KKRNF403
KM    Norland Sub RNF40
KO      0       0       0       0      22
BA   5.66
LS      0     100       0
UC  13.51   13.51
*  rnf40
UA      0     0.1    0.29     0.5    0.62    0.74     0.8    0.86    0.91    0.95
UA      1
KKADH403
```

```
KO      0        0        0        0       22
HC      2
KKRCH403
KM     Lat 3 JD 61
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC  0.08     0.05     0.08     9650    0.006        0
*  rch403
RX      0        5       10       22       30       42       47      252
RY1070.1     1070     1069     1065     1065     1069     1070  1070.1
KKRNF405
KM     Norland sub RNF60
KO      0        0        0        0       22
BA  7.08
LS      0      100        0
UC 11.04    11.04
*  rnf405
UA      0     0.08     0.18     0.31     0.51     0.65     0.82      0.9     0.97     0.99
UA      1
KKADH405
KM     Sec 21/22 T163N R38W
KO      0        0        0        0       22
HC      2
KKRNF406
KM     Norland sub RNF65
KO      0        0        0        0       22
BA  1.71
LS      0      100        0
UC      5     5.85
*  rnf406
UA      0     0.13     0.25     0.34     0.45     0.57      0.7      0.8     0.89     0.97
UA      1
KKADH406
KM     Sec 21/22 T163N R38W
KO      0        0        0        0       22
HC      2
KKRNF408
KM     Norland Pool area RNF70
KO      0        0        0        0       22
BA  7.65
LS      0      100        0
UC 12.55    18.83
*  rnf408
UA      0     0.02     0.08     0.15     0.26     0.41     0.61     0.75     0.87     0.93
UA      1
KKADH408
KO      0        0        0        0       22
HC      2
KKDVT408
KM Split Norland flows into BR 5 Lat 3 and Lat 3 flows
DTOUT410
*  in410
DI     0.      35.      99.     239.     443.     696.    1065.    1515.    2032.
*  out410
DQ     0.      11.      33.      80.     148.     232.     355.     505.     677.
KKRCH420
KM     Lat 3 JD 61
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125     0.05    0.125    24200   0.0006        0
*  rch420
RX      0        6        8       18       24       34     1320     1325
RY   1054     1051     1050     1045     1045     1050     1050     1054
KKADH421
KO      0        0        0        0       22
```

```
HC     2
KKRCH421
KM    Roseau River Lat 3 JD 61 to Hwy 310
KO     0       0       0       0      22
RS     1    STOR       0       0
*  stor421
SV     0     312     459     792    2106    7611   10140   12450   14757   18993
*  flow421
SQ     0     561    1000    2000    3000    5000    6000    7000    8000   10000
KKRTV430
KM    Br 5 Lat 3 JD61
DROUT410
KKRCH430
RS     4    FLOW       0       0
RC 0.125    0.05   0.125   44000  0.0004       0
*  out410
RX     0       6       8      18      24      34    1320    1325
RY  1054    1051    1050    1045    1045    1050    1050    1054
KKADH430
KO     0       0       0       0      22
HC     2
KKRNF499
KM    Local drainage Roseau River at MN Hwy 310
KO     0       0       0       0      22
BA 19.26
LS     0     100       0
UC 18.59   32.35
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH499
KM    Roseau River at MN Hwy 310
KO     0       0       0       0      22
HC     2
KKRNF520
KM    East Fork of Sprague Creek
KO     0       0       0       0      22
BA 22.42
LS     0     100       0
UC  43.2    64.8
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF530
KM    West Fork of Sprague Creek
KO     0       0       0       0      22
BA 20.42
LS     0     100       0
UC 48.32   72.48
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH530
KO     0       0       0       0      22
HC     2
KKRCH530
KM    Sprague Creek forks to Vasser Road
KO     0       0       0       0      22
RS     6    FLOW       0       0
RC 0.125    0.04   0.125   40765  0.0006       0
*  rch530
RX     0      10     510     516     534     540    1040    1050
RY  1080    1075    1073    1067    1067    1073    1075    1080
KKRNF540
KM    Local drainage to Sprague Creek at Vassar Road
KO     0       0       0       0      22
BA 47.64
LS     0     100       0
```

```
UC 43.35   65.03
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH540
KO     0       0       0       0      22
HC     2
KKRCH540
KM    Sprague Creek Vassar Road to Mud Creek
KO     0       0       0       0      22
RS     5    FLOW       0       0
RC 0.125    0.04   0.125   56058  0.0005       0
*  rch540
RX     0      10     510     516     534     540    1040    1050
RY  1075    1070    1068    1062    1062    1068    1070    1075
KKRNF545
KM    Local drainage Sprague Creek at Sprague Manitoba
KO     0       0       0       0      22
BA 21.93
LS     0     100       0
UC  35.7   53.55
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH545
KM    Sprague Creek at Sprague
KO     0       0       0       0      22
HC     2
KKRNF510
KM    Local Drainage to Mud Creek
KO     0       0       0       0      22
BA 32.18
LS     0     100       0
UC 71.13   106.7
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH546
KO     0       0       0       0      22
HC     2
KKRCH546
KM    Sprague Creek Sprague to USGS Gage
KO     0       0       0       0      22
RS     2    FLOW       0       0
RC 0.125    0.04   0.125   17973  0.0009       0
*  rch546
RX     0      10     510     516     534     540    1040    1050
RY  1065   10602    1057    1051    1051    1057    1060    1065
KKRNF550
KM    Local drainage Sprague Creek at USGS Gage
KO     0       0       0       0      22
BA 39.01
LS     0     100       0
UC 52.83    35.4
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH550
KM Sprague Creek at USGS gaging station
KO     0       0       0       0      22
HC     2
KKRCH550
KM    Sprague Creek USGS Gage to Lat 2 JD 61
KO     0       0       0       0      22
RS     3    FLOW       0       0
RC 0.125    0.04   0.125   32800  0.0006       0
*  rch550
RX     0      50    1850    1856    1874    1880    2980    3030
RY  1050    1047    1045    1039    1039    1045    1047    1050
```

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KKRNF570
KM    Local Drainage to Upper Lat 2 JD 61
KO      0       0       0       0      22
BA 54.33
LS      0     100       0
UC 39.24   58.86
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRTV402
KM    Split flow out of RNF402
DROUT402
KKRCH571
RS      1    FLOW       0       0
RC  0.08    0.05    0.08   10420  0.0006       0
*  rch571
RX      0       2       4      10      24      30    1300    2600
RY   1081    1080    1079    1076    1076    1079  1079.5    1080
KKADH574
KO      0       0       0       0      22
HC      2
KKRCH574
KM    Lat 2 JD 61
KO      0       0       0       0      22
RS      4    FLOW       0       0
RC 0.125    0.05   0.125   31460  0.0005       0
*  rch574
RX      0       1       5       9      17      21    2621    2655
RY   1047    1046    1042    1038    1038    1042    1043    1045
KKADH575
KO      0       0       0       0      22
HC      2
KKRCH575
KM    Sprague Creek Br2 JD 61 to Outlet
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.04   0.125    9000  0.0005       0
*  rch575
RX      0      15    1515    1521    1541    1547    2547    2555
RY   1036    1033    1032    1026    1026    1032    1033    1035
KKRNF580
KM    Local drainage to Sprague Creek at Outlet
KO      0       0       0       0      22
BA 47.32
LS      0     100       0
UC     29    43.5
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH580
KM    Sprague Creek at Outlet
KO      0       0       0       0      22
HC      2
KKADH456
KM Combined flows Roseau River and Sprague Creek
KO      0       0       0       0      22
HC      2
KKRCH456
KM    Roseau Rive Sprague Creek to Roseau Lake Bed
KO      0       0       0       0      22
RS      3    FLOW       0       0
RC 0.125   0.035   0.125   27200  0.0002       0
*  rch456
RX      0    1320    2640    2665    2718    2743    4063    5390
RY   1035 1034.25    1034  1021.5  1021.5    1034 1034.25    1035
KKRNF610
KM    South Roseau Lake Bottom
```

```
KO      0       0       0       0       22
BA 40.91
LS      0     100       0
UC 10.48    7.02
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKRNF620
KM    North Roseau Lake Bottom
KO      0       0       0       0       22
BA  46.2
LS      0     100       0
UC 40.11   40.11
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH620
KM    Roseau River at Lake Bed
KO      0       0       0       0       22
HC      3
KKRNF700
KM    Local Drainage West Pine Creek
KO      0       0       0       0       22
BA 33.76
LS      0     100       0
UC 56.23   37.67
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH700
KM    West Pine Creek Manitoba Hwy 12 to East Pine Creek
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    1672  0.0014       0
*  rch700
RX      0     750    1500    1510    1518    1528    2278    3000
RY  1100    1095    1090    1086    1086    1090    1091    1095
KKRNF710
KM    Local drainage East Pine Creek
KO      0       0       0       0       22
BA  9.55
LS      0     100       0
UC 20.36   13.63
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH710
KM    East Pine Creek Manitoba Hwy 12 to West Pine Creek
KO      0       0       0       0       22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    2048  0.0014       0
*  rch710
RX      0     750    1500    1510    1516    1526    2276    3000
RY  1095    1091    1090    1086    1086    1090    1095    1100
KKADH710
KM    Pine Creek near Hwy 12
KO      0       0       0       0       22
HC      2
KKRCH711
KM East and West Pine Creek to Diversion
KO      0       0       0       0       22
RS     1.    FLOW       0
RC 0.125    0.05   0.125   19288  0.0014
*  rch711
RX      0     750    3000    3010    3016    3026    5250    6000
RY  1095    1090    1085    1081    1081    1085    1090    1095
KKRNF720
KM    Local drainage Pine Creek at Diversion
KO      0       0       0       0       22
```

```
BA 16.68
LS      0      100        0
UC  7.58     5.08
* fan
UA      0    0.05     0.15     0.35     0.65        1
KKADH720
KM Pine Creek Upstream of Diversion
KO      0        0        0        0       22
HC     2.
KKDVT720
KM Pine Creek Diversion
DTOUT720
*  in720
DI     0.     220.     300.     500.    1000.    1250.    1500.    2000.
*  out720
DQ     0.     220.     273.     407.     740.     850.     850.     850.
KKRCH720
KM     Pine Creek Diversion to Roseau County Road 118
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125     0.04    0.125    37815    0.001        0
*  rch720
RX      0      600     1180     1184     1192     1196     1700     2410
RY   1050     1047     1045    10417     1041     1045     1047     1050
KKRNF790
KM     Local Drainage at RCR 118
KO      0        0        0        0       22
BA 20.29
LS      0      100        0
UC 17.76    17.76
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH790
KM     Pine Creek at Lake Bottom
KO      0        0        0        0       22
HC      2
KKADH699
KO      0        0        0        0       22
HC      2
KKRSV699
KM     Roseau Lake Bottom
KO      0        0        0        0       22
RS      1     FLOW     2430        0
*  stor699
SV      0      500     1100     3000     5580    12970    17860    28000    40000    52260
SV  60590    74010    84505   144375   179500   203000
*  flow699
SQ      0      250      732      954     1136     1372     1638     1924     2222     2574
SQ   3084     3868     4494     5200     7500    10000
*  elev699
SE1017.1   1024.8     1026     1027     1028     1029     1030     1031     1032     1033
SE   1034     1035   1035.5     1036     1037     1038
KKRCH699
KM     Roseau River Ross to Lins Bridge
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125    0.035    0.125    24390   0.0005        0
*  rch699
RX      0        9     3200     3232     3299     3331     5271     5280
RY   1035     1032     1030     1014     1014     1030     1032     1035
KKRNF900
KM     Local drainage at Lins Bridge
KO      0        0        0        0       22
BA 41.99
LS      0      100        0
```

```
UC 14.73    9.87
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKADH900
KO     0       0       0       0      22
HC     2
KKRCH900
KM    Roseau River Lins Bridge to Big Swamp
KO     0       0       0       0      22
RS     2    FLOW       0       0
RC 0.125   0.035   0.125   24390  0.0004       0
*  rch900
RX     0      25      35      67     134     166    2806    5280
RY  1035    1030    1028    1012    1012    1028    1030    1032
KKRNF920
KM    Local drainage upstream of Big Swamp
KO     0       0       0       0      22
BA 24.09
LS     0     100       0
UC 32.83   32.83
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKADH920
KO     0       0       0       0      22
HC     2
KKRCH920
KM    Roseau River to Roseau River Wildlife Management Pool 2 Outlet
KO     0       0       0       0      22
RS    52    FLOW       0       0
RC 0.125   0.035   0.125   13000  0.0004       0
*  rch920
RX     0    2640    5280    5296    5363    5380    8020   10659
RY  1025  1024.5    1024    1018    1018    1024  1024.5    1025
KKRNF810 RRWMA Pool 1
KM    Local Drainage to RRWMA Pool 1
KO     0       0       0       0      22
BA 24.88
LS     0     100       0
UC  13.3    13.3
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKRTV720
KM    Pine Creek Diversion
DROUT720
KKRC720a
RS     3    FLOW       0       0
RC  0.05    0.05    0.05   41517  0.0001       0
*  rc720a
RX     0      10      28      42      52      66      84      94
RY  1068    1063    1063    1056    1056    1063    1063    1068
KKADH810
KO     0       0       0       0      22
HC     2
KKRSV810
KM    RRWMA Pool 1
KO     0       0       0       0      22
RS     1    STOR    2415       0
*  stor810
SV  2415    2477    3968    4899    4215    4575    5115    5475    6415    6735
*  flow810
SQ     0     8.4      33     235     460     820    1390    1960    3035    4735
*  elev810
SE  1035  1035.2  1035.5  1035.8    1036  1036.2  1036.5  1036.7    1037  1037.4
KKRNF820
KM    Local drainage RRWMA Pool 2
```

```
KO      0       0       0       0      22
BA 89.71
LS      0     100       0
UC     51    76.5
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH820
KO      0       0       0       0      22
HC      2
KKRSV820
KM     RRWMA Pool 2
KO      0       0       0       0      22
RS      1    STOR    4450       0
*  stor820
SV   4450    5400    6800    8400    9500   10800   12800   14300   16540   19550
*  flow810
SQ      0     8.4      33     235     460     820    1390    1960    3035    4735
*  elev820
SE   1029  1029.2  1029.5  1029.8    1030  1030.2  1030.5  1030.7    1031  1031.4
KKDVT820
KM Main outlet Roseau River, Emergency Spillway and Secondary Outlet
DTOUT820
*  in820
DI     0.     8.4     33.    235.    460.    820.   1390.   1960.   3035.   4735.
*  out820
DQ     0.      0.      0.    170.    370.    700.   1225.   1645.   2345.   3325.
KKRCH821
KM     Roseau County Ditch 17
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    3900  0.0001       0
*  rch821
RX      0    1050    2100    2108    2116    2124    2128    2134
RY   1025    1022    1020    1016    1016    1020    1022    1025
KKRCH822
KM     Old Roseau River Channel
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    8800  0.0001       0
* rch822
RX      0     500    1400    1408    1548    1556    2500    4000
RY   1024    1022    1020    1016    1016    1020    1022    1024
KKADH930
KO      0       0       0       0      22
HC      2
KKRCH930
KM     Roseau River Pool 2 outlet to Pool 3 outlet
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   15200  0.0004       0
*  rch930
RX      0    2640    5280    5296    5363    5380    8020   10659
RY   1020  1019.5    1019    1013    1013    1019  1019.5    1020
KKRNF830
KM     Local drainage RRWMA Pool 3
KO      0       0       0       0      22
BA 23.73
LS      0     100       0
UC   12.5    12.5
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRTV820
KM     Pool 2 outflow to Pool3
DROUT820
KKADH830
```

```
KO      0       0       0       0      22
HC      2
KKRSV830
KM     RRWMA Pool 3
KO      0       0       0       0      22
RS      1    STOR    2700       0
*  stor830
SV   2700    3400    4500    5800    6750    7750    9700   12900   16650
*  flow830
SQ      0     8.4      33     185     355     620    1040    1925    2980
*  elev830
SE   1024  1024.2  1024.5  1024.8    1025  1025.2  1025.5    1026  1026.5
KKRCH831
KM     Outlet Channel Pool3
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    2920  0.0001       0
*  rch831
RX      0     700    1400    1410    1420    1430    2100    3000
RY   1023    1022    1021    1016    1016    1021    1022    1023
KKRCH832
KM     Old Roseau River Channel
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    1150  0.0001       0
*  rch832
RX      0     700    1400    1412    1512    1514    2100    3000
RY   1023    1022    1021    1015    1015    1021    1022    1023
KKADH940
KO      0       0       0       0      22
HC      2
KKRCH940
KM     Roseau River pool 3 to end of Big Swamp
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   34000  0.0004       0
*  rch940
RX      0    2640    5280    5296    5363    5380    8020   10659
RY   1019  1018.5    1018    1012    1012    1018  1018.5    1019
KKRNF950
KM     Local drainage Big Swamp
KO      0       0       0       0      22
BA 88.82
LS      0     100       0
UC 32.48   48.72
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH950
KO      0       0       0       0      22
HC      2
KKRSV950
KM      Big Swamp Storage
KO      0       0       0       0      22
RS      1    STOR       0       0
*  stor950
SV      0    2000    6000   13000   21000   29000   37000   45000   53000   69000
*  flow950
SQ      0     700    1300    1900    2300    2600    2900    3200    3500    4100
KKDVT950
KM Flow transfer to Two Rivers
DTOUT920
*  in920
DI     0.   2000.   3513.   3699.   4403.
*  out920
DQ     0.      0.    533.    619.   1083.
```

```
KKRCH950
KM    Roseau River Big Swamp to USGS Gaging Station
KO      0       0       0       0      22
RS      3    FLOW       0       0
RC 0.125   0.035   0.125   32900  0.0002       0
*  rch950
RX      0    1600    2200    2220    2275    2295    2900    3250
RY   1020    1018    1015    1005    1005    1015    1018    1020
KKRNF960
KM    Local drainage to USGS Gage near Caribou
KO      0       0       0       0      22
BA 24.04
LS      0     100       0
UC 24.04    33.8
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH960
KO      0       0       0       0      22
HC      2
KKRCH960
KM    Roseau River Caribou to International Border
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   12200   .0003       0
*  rch960
RX      0    1600    2200    2220    2275    2295    2900    3250
RY   1015    1013    1010    1000    1000    1010    1013    1015
KKRNF999
KM    Local Drainage Roseau River at Border
KO      0       0       0       0      22
BA  9.56
LS      0     100       0
UC 13.78   13.78
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH999
KM    Roseau River at International Border
KO      0       0       0       0      22
HC      2
KKRTV920
KM Diverted flow to Two Rivers
DROUT920
ZZ
```

Appendix C

HEC-1 Input
Summer Rainfall Events

```
ID       Roseau River Watershed District
ID       Developed by JOR Engineering, Inc. Crookston, MN
ID       10 Day Summer Event 6/11/01 Michael Bakken
*DIAGRAM
IT   480  1JAN94       0     150
IO     0
JD          1432
PH     1                              2.25    2.71    3.00    3.55    4.23    5.00
PH  5.85    7.00    7.99    8.70
PH     2                              2.09    2.50    2.76    3.25    3.85    4.59
PH  5.40    6.49    7.40    8.00
PH     4                              1.89    2.24    2.49    2.93    3.45    4.10
PH  4.85    5.79    6.55    7.10
PH    10                              1.59    1.88    2.09    2.48    2.92    3.45
PH  4.08    4.90    5.55    6.00
PH    20                              1.28    1.52    1.70    2.00    2.39    2.82
PH  3.35    4.00    4.59    5.00
PH    50                              0.99    1.19    1.31    1.58    1.86    2.20
PH  2.61    3.09    3.52    3.83
PH    99                              0.82    1.01    1.16    1.37    1.61    1.91
PH  2.27    2.69    3.02    3.17
KK  RNF9
KM    Local Drainage to Roseau River Flowage
KO     0       0       0       22
BA 40.81
LS     0      58       0
UC 35.53   82.78
* fan
UA     0    0.05    0.15    0.35    0.65       1
KK  RSV9
KM     Roseau River Flowage Impoundment
KM      Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO     0       0       0       0      22
RS     1    STOR     240       0
* rsv9stor
SV   240     310     400     500     643     940    1092    1245    1550
* rsv9flow
SQ     0      52     155     288     435     800    1225    1913    3663
* Rsv9elev
SE  1230  1230.5    1231  1231.5    1232    1233  1233.5    1234    1235
KK  RCH9
KM     North Branch Downstream of Roseau River Flowage
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   11200  0.0004       0
* rch9
RX     0     700     750     756     780     786     900    2800
RY  1230    1225    1224    1218    1218    1224    1225    1230
KK RNF15
KM    local drainage to DNR dam 3 Non-functional
KO     0       0       0       0      22
BA 13.69
LS     0      50       0
UC 25.65    51.3
* diamond
UA     0    0.09    0.34    0.64     0.9       1
KK ADH15
KO     0       0       0       0      22
HC     2
KK RCH15
KM     North Branch Downstream of DNR dam 3
KO     0       0       0       0      22
RS     2    FLOW       0       0
RC 0.125   0.035   0.125   12800  0.0004       0
* rch15
```

```
RX      0     820    1000    1006    1030    1036    1400    2500
RY   1225    1220    1219    1213    1213    1219    1220    1225
KK RNF19
KM    Local Drainage to DNR dam 4 Non-functional
KO      0       0       0       0      22
BA    5.8
LS      0      56       0
UC  14.88   29.76
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH19
KO      0       0       0       0      22
HC      2
KKRCH19a
KM    North Branch downstream of DNR dam 4
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.125   0.035   0.125    9400  0.0011       0
* rch19a
RX      0     510     690     696     720     726     990    1690
RY   1225    1220    1209    1203    1203    1209    1220    1225
KK RC19b
KM    North Branch downstream of DNR dam 4
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC  0.125   0.035   0.125   26000  0.0012       0
* rch19b
RX      0     200     280     286     318     324     390     450
RY   1210    1200    1195  1188.5  1188.5    1195    1200    1210
KK RNF25
KM    Local drainage to North Branch at Hanson Creek
KO      0       0       0       0      22
BA  12.52
LS      0      43       0
UC   18.8    37.6
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KK ADH25
KM     North Branch Upstream of Hanson Creek
KO      0       0       0       0      22
HC      2
KK RNF29
KM    DNR dam 1 on Hanson Creek
KO      0       0       0       0      22
BA  12.73
LS      0      58       0
UC  34.28   79.87
* fan
UA      0    0.05    0.15    0.35    0.65       1
KK RSV29
KM    DNR dam 1 on Hanson Creek
KM     Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0       0       0       0      22
RS      1    STOR     320       0
* rsv29stor
SV    320     370     450     650     670     810     960    1360
* rsv29flow
SQ      0    57.5     166     319     558     934    1310    4235
* rsv29elev
SE   1219  1219.5    1220  1220.5    1221  1221.5    1222    1223
KK RCH29
KM    Hanson Creek downstream of DNR dam 1
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC  0.125   0.035   0.125    6000  0.0009       0
```

```
* rch29
RX      0     400     800     803     818     821    1100    1480
RY   1220    1215    1214    1211    1211    1214    1215    1220
KK RNF35
KM    Non-functional DNR dam 2 on Hanson Creek
KO      0       0       0       0      22
BA    4.9
LS      0      46       0
UC  22.66    52.8
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH35
KO      0       0       0       0      22
HC      2
KK RCH35
KM    Hanson Creek from DNR dam 2 to Winner Dam
KO      0       0       0       0      22
RS      5    FLOW       0       0
RC  0.125   0.035   0.125   17000  0.0006       0
*  rch35
RX      0     110     310     316     336     342     600    1000
RY   1210    1205    1204    1198    1198    1204    1205    1210
KK RNF39
KM     Local drainage to Winner Dam
KO      0       0       0       0      22
BA  13.36
LS      0      46       0
UC  40.79   95.04
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH39
KO      0       0       0       0      22
HC      2
KK RSV39
KM    Winner Dam impoundment on Hanson Creek
KM     Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0       0       0       0      22
RS      1    STOR       5       0
* rsv39stor
SV      5      21      30      65     120     220     370     470     580
* rsv39flow
SQ      0       6      32      75     170     320     560     920    1500
* rsv39elev
SE1201.5    1202    1203    1204    1205    1206    1207  1207.5    1208
KK RCH39
KM     Hanson Creek Winner dam to North Branch
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.125   0.035   0.125   20500  0.0013       0
* rch39
RX      0     700     990     996    1036    1042    1290    1680
RY   1205    1200    1194    1182    1182    1194    1200    1205
KK RNF45
KM    Local drainage to outlet of Hanson Creek
KO      0       0       0       0      22
BA   5.59
LS      0      38       0
UC  16.96   33.92
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KK ADH45
KM    Hanson Creek outflow
KO      0       0       0       0      22
HC      2
KK ADH46
```

```
KO      0       0       0       0      22
HC      2
KK RCH46
KM    North Branch from Hanson Creek to Hayes Lake
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   11000  0.0007       0
* rch46
RX      0     200     350     358     390     398     460     990
RY   1190    1175    1169    1161    1161    1169    1175    1190
KK RNF49
KM    Local drainage to Hayes Lake
KO      0       0       0       0      22
BA 18.29
LS      0      45       0
UC 60.89  121.78
* diamond
UA      0    0.09    0.34    0.64     0.9       1
KK ADH49
KO      0       0       0       0      22
HC      2
KK RSV49
KM    Hayes Lake Dam
KM      Outlet and Storage curves developed by Dan Thul (MNDNR 1981)
KO      0       0       0       0      22
RS      1    STOR    1640       0
* rsv49stor
SV      0     180     595    1290    1640    1680    1750    1840    2050    2270
SV   2510    2760    3000    3070    3180    3250
* rsv49flow
SQ      0       0       0       0       0      19      72     213     640    1235
SQ   2000    2950    4060    4610    5140    8150
* rsv49elev
SE   1150    1155    1160    1165    1167  1167.2  1167.5    1168    1169    1170
SE   1171    1172    1173  1173.4  1173.7    1174
KK RCH49
KM    North Branch Hayes Lake to Beaver
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   28200   0.001       0
* rch49
RX      0      90     160     168     228     236     690     800
RY   1150    1135    1130    1122    1122    1130    1135    1150
KK RNF59
KM    Local Drainage to Beaver
KO      0       0       0       0      22
BA 15.71
LS      0      47       0
UC 43.26   64.89
* fan
UA      0    0.05    0.15    0.35    0.65       1
KK ADH59
KO      0       0       0       0      22
HC      2
KK RCH59
KM     North Branch to Pencer
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   38000  0.0009       0
* rch59
RX      0     110    1000    1008    1068    1072    1690    1770
RY   1125    1120    1115    1107    1107    1115    1120    1125
KK RNF65
KM    Local drainage to Pencer East
KO      0       0       0       0      22
```

```
BA 12.79
LS      0       49        0
UC 15.54    12.43
* fan
UA      0     0.05     0.15     0.35     0.65        1
KK ADH65
KO      0        0        0        0       22
HC      2
KK RCH65
KM     North Branch to Severson Creek
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    25509   0.0008        0
*  rch65
RX      0       80      250      270      330      350     1580     1680
RY   1095     1090     1085     1075     1075     1085     1090     1095
KK RNF69
KM     Local drainage to North Branch at Severson Creek
KO      0        0        0        0       22
BA   2.29
LS      0       54        0
UC   7.24     7.24
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KK ADH69
KO      0        0        0        0       22
HC     2.
KKRNF070
KM     Severson Creek
KO      0        0        0        0       22
BA 22.25
LS      0       50        0
UC   17.3     17.3
* fan
UA      0     0.05     0.15     0.35     0.65        1
KK ADH70
KO      0        0        0        0       22
HC      2
KKRCH070
KM     North Branch to Bear Creek
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    29973   0.0008        0
*  rch70
RX      0       80      250      270      330      350     1580     1680
RY   1085     1080     1075     1065     1065     1075     1080     1085
KKRNF079
KM      Local drainage North Branch at Bear Creek
KO      0        0        0        0       22
BA   7.52
LS      0       52        0
UC 13.14    13.14
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KK ADH79
KO      0        0        0        0       22
HC      2
KK RNF80
KM     Local Drainage Comstocks  Bear Creek at Roseau CSAH 9
KO      0        0        0        0       22
BA 20.66
LS      0       55        0
UC   16.8    14.11
* fan
UA      0     0.05     0.15     0.35     0.65        1
```

```
KK RCH80
KM    Bear Creek Comstock to North Branch
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    28200   0.0008        0
*  rch80
RX      0      180      400      406      456      462      640      820
RY   1080     1075     1070     1064     1064     1070     1075     1080
KK RNF85
KM    Local drainage Bear Creek at outlet
KO      0        0        0        0       22
BA   5.27
LS      0       54        0
UC 11.08     8.64
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KK ADH85
KM    Bear Creek at North Branch
KO      0        0        0        0       22
HC      2
KK ADH86
KO      0        0        0        0       22
HC      2
KK RCH86
KM    North Branch from Bear Creek to Malung
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    20800   0.0006        0
*  rch86
RX      0      260      350      354      411      415      490      710
RY   1070     1055     1054     1050     1050     1054     1055     1070
KK RNF99
KM    Local Drainage to Gage 2
KO      0        0        0        0       22
BA   2.18
LS      0       57        0
UC   3.96     2.65
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KK ADH99
KO      0        0        0        0       22
HC      2
KKRSV99
KM temporary calibration reservoir
RS      1     STOR        0
*  rsv99stor
SV      0      800     1200     4800     6500     7000     7300     7400     7800     8000
*  rsv99flow
SQ      0      100      200      500     1000     1500     2500     3000     5000    15000
KK RCH99    CNAME       G2
KM    North Branch gage 2 to South Branch
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    17800   0.0004        0
*  rch99
RX      0      110      180      186      246      252      260      810
RY   1055     1050     1044     1038     1038     1044     1050     1055
KKRNF109
KM    Local drainage South Branch at Skime
KO      0        0        0        0       22
BA 28.21
LS      0       55        0
UC 67.63   157.58
* fan
UA      0     0.05     0.15     0.35     0.65        1
```

```
KKRCH109
KM    South Branch Skime to Casperson
KO     0       0       0       0      22
RS     2    FLOW       0       0
RC 0.125   0.035   0.125   34800  0.0007       0
*  rch109
RX     0    1400    1620    1624    1664    1668    2150    3220
RY  1175    1170    1165    1161    1161    1165    1170    1175
KKRCH110
KM    South Branch Casperson to Mickinock Creek
KO     0       0       0       0      22
RS     3    FLOW       0       0
RC 0.125   0.035   0.125   35000  0.0012       0
*  rch110
RX     0     280     300     305     345     349     400     540
RY  1135    1130    1125    1120    1120    1125    1130    1135
KKRNF119
KM    Local drainage to South Branch at Mickinock Creek
KO     0       0       0       0      22
BA  24.2
LS     0      56       0
UC 25.87   51.74
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKADH119
KM    Combined flow South Branch upstream of Mickinock Creek
KO     0       0       0       0      22
HC     2
KKRNF120
KM     Palmville sub RNF3
KM    Palmville sub refers to areas developed for the Palmville Flood Control P
KO     0       0       0       0      22
BA  1.27
LS     0      60       0
UC  7.06   14.12
* fan
UA     0    0.05    0.15    0.35      65       1
KKRCH120
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.15    0.15    5500  0.0018       0
*  rch120
RX     0      10      20     500     800    1300    1310    1320
RY  1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF121
KM    Palmville sub RNF4b
KO     0       0       0       0      22
BA  0.95
LS     0      63       0
UC  9.62   19.24
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRCH121
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.15    0.15    5500  0.0009       0
*  rch121
RX     0      10      20     500     800    1300    1310    1320
RY  1172    1171  1170.5    1170    1170  1170.5    1171    1172
KKRNF123
KM    Palmville sub RNF4a
KO     0       0       0       0      22
BA  2.32
LS     0      62       0
UC  6.98   13.96
```

```
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH123
KO      0        0        0        0       22
HC      2
KKRCH123
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     2500    0.004        0
*  rch120
RX      0       10       20      500      800     1300     1310     1320
RY   1170     1169   1168.5     1168     1168   1168.5     1169     1170
KKADH124
KO      0        0        0        0       22
HC      2
KKRNF125
KM      Palmville sub RNF5
KO      0        0        0        0       22
BA   4.44
LS      0       54        0
UC   15.4     30.8
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH125
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     1500   0.0033        0
*  rch120
RX      0       10       20      500      800     1300     1310     1320
RY   1170     1169   1168.5     1168     1168   1168.5     1169     1170
KKRNF126
KM      Palmville sub RNF6
KO      0        0        0        0       22
BA   1.25
LS      0       57        0
UC 11.52    17.28
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH126
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     8000   0.0006        0
*  rch120
RX      0       10       20      500      800     1300     1310     1320
RY   1170     1169   1168.5     1168     1168   1168.5     1169     1170
KKRNF127
KM      Palmville sub RNF7
KO      0        0        0        0       22
BA   2.93
LS      0       48        0
UC 16.27    16.27
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KKRCH127
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC   0.15     0.15     0.15     9000   0.0006        0
*  rch120
RX      0       10       20      500      800     1300     1310     1320
RY   1170     1169   1168.5     1168     1168   1168.5     1169     1170
KKRNF128
KM      Palmville sub RNF8
KO      0        0        0        0       22
BA   1.22
LS      0       47        0
```

```
UC  6.25    9.38
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRCH128
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.15    0.15    6000  0.0008       0
*  rch120
RX     0      10      20     500     800    1300    1310    1320
RY  1170    1169  1168.5    1168    1168  1168.5    1169    1170
KKRNF129
KM     Palmville sub RNF9
KO     0       0       0       0      22
BA   2.9
LS     0      47       0
UC  7.84   11.76
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF130
KM     Palmville sub RNF10
KO     0       0       0       0      22
BA  1.29
LS     0      45       0
UC  5.11   11.91
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH130
KO     0       0       0       0      22
HC     7
KKRNF131
KM     Palmville wildlife pool
KO     0       0       0       0      22
BA  7.65
LS     0      62       0
UC 13.89   32.36
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH131
KO     0       0       0       0      22
HC     2
KKRNF132
KM     Palmville Flood Pool
KO     0       0       0       0      22
BA  0.89
LS     0      62       0
UC  7.85   18.29
* diamond
UA     0    0.09    0.34    0.64     0.9       1
KKADH132
KO     0       0       0       0      22
HC     2
KKRCH132
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.05    0.15   10560  0.0005       0
*  rch132
RX     0       4       6      16      24      34    1320    1325
RY  1153    1151    1149    1144    1144    1149    1150    1152
KKRCH133
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.15    0.05    0.15    9200  0.0016       0
*  rch133
RX     0       4       6      22      30      46    1320    1325
RY  1148    1146    1144    1136    1136    1144    1144    1146
```

```
KKRNF139
KM     Local drainage to Oseland Gage
KO     0       0       0       0      22
BA 23.74
LS     0      56       0
UC  21.3   31.95
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH139
KO     0       0       0       0      22
HC     2
KKRCH139
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125   14800  0.0006       0
*  rch139
RX     0     140     200     204     224     228     305     350
RY  1127    1120    1119    1115    1115    1119    1120    1127
KKRNF145
KM    Local drainage to Mickinock Creek at Outlet
KO     0       0       0       0      22
BA  8.37
LS     0      54       0
UC 18.97   18.97
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH145
KM    Mickinock Creek
KO     0       0       0       0      22
HC     2
KKADH146
KO     0       0       0       0      22
HC     2
KKRCH146
KM     South Branch Mickinock Creek to Wannaska
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   26600  0.0009       0
*  rch146
RX     0      90     120     127     167     174     305     390
RY  1110    1105    1100    1093    1093    1100    1105    1110
KKRNF149
KM    Local drainage South Branch at Wannaska
KO     0       0       0       0      22
BA    14
LS     0      54       0
UC 19.28   19.28
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH149
KO     0       0       0       0      22
HC     2
KKRCH149
KM     South Branch Wannaska to Paulson Creek
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   15200  0.0004       0
*  rch149
RX     0     175     300     306     346     352     775     800
RY  1100    1095    1090    1084    1084    1090    1095    1100
KKRNF155
KM     Local drainage South Branch at Paulson Creek
KO     0       0       0       0      22
BA  4.45
LS     0      53       0
```

```
UC  6.05    4.05
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH155
KO     0       0       0       0      22
HC     2
KKRNF159
KM     Local drainage gage 43  Roseau CD 21 at CSAH4
KO     0       0       0       0      22
BA 20.07
LS     0      55       0
UC 20.56   27.76
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRCH159
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    8500  0.0005       0
*  rch159
RX     0     7.5      15      30      38      53    1373    2700
RY  1125  1122.5    1120    1115    1115    1120  1122.5    1125
KKRCH160
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125    4400  0.0036       0
*  rch160
RX     0     150     180     185     195     200     300     400
RY  1115    1100    1095    1090    1090    1095    1100    1115
KKRNF165
KM     Local Drainage Paulson Creek at Outlet
KO     0       0       0       0      22
BA  3.47
LS     0      53       0
UC 10.25   10.25
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH165
KM    Combined outflow Paulson Creek
KO     0       0       0       0      22
HC     2
KKADH166
KO     0       0       0       0      22
HC     2
KKRCH166
KM     South Branch Paulson Creek to Pencer West
KO     0       0       0       0      22
RS     2    FLOW       0       0
RC 0.125   0.035   0.125   29800  0.0004       0
*  rch166
RX     0     160     500     520     580     600     650     700
RY  1090    1080    1080    1070    1070    1080    1085    1090
KKRNF169
KM    Local Drainage to Pencer West
KO     0       0       0       0      22
BA  6.56
LS     0      61       0
UC 14.79   14.79
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH169
KO     0       0       0       0      22
HC     2
KKRCH169
KM    South Branch Pencer West to Unamed Creek 1
KO     0       0       0       0      22
```

```
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    17000   0.0005        0
*  rch169
RX      0       90      690      712      752      774      800      850
RY   1075     1070     1065     1054     1054     1065     1070     1075
KKRNF170
KM     Local draiange South Branch at Unamed Creek 1
KO      0        0        0        0       22
BA   1.65
LS      0       61        0
UC   6.34     6.34
*  general
UA      0     0.13     0.36     0.67     0.89        1
KKADH170
KM     South Branch upstream Unamed Creek 1
KO      0        0        0        0       22
HC      2
KKRNF171
KM     Local Drainage Unamed Creek 1
KO      0        0        0        0       22
BA  13.67
LS      0       54        0
UC  19.15    19.15
*  fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH171
KO      0        0        0        0       22
HC      2
KKRCH171
KM     South Branch Unamed Creek 1 to Unamed Creek 2
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    34400   0.0005        0
*  rch171
RX      0       90      690      712      752      774      800      850
RY   1070     1065     1060     1049     1049     1060     1065     1070
KKRNF172
KM     Local drainage South Branch at Unamed Creek 2
KO      0        0        0        0       22
BA   5.04
LS      0       60        0
UC  16.23    16.23
*  diamond
UA      0     0.09     0.34     0.64      0.9        1
KKADH172
KM     South Branch upstream Unamed Creek 2
KO      0        0        0        0       22
HC      2
KKRNF173
KM     Local drainage Unamed Creek 2
KO      0        0        0        0       22
BA  16.03
LS      0       53        0
UC  16.17    16.17
*  fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH173
KO      0        0        0        0       22
HC      2
KKRCH173
KM     South Branch Unamed Creek 2 to Gage 1
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    27000   0.0005        0
*  rch173
```

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RX      0      90     690     712     752     774     800     850
RY   1065    1060    1055    1044    1044    1055    1060    1065
KKRNF199
KM     Local drainage to Gage 1
KO      0       0       0       0      22
BA   9.25
LS      0      57       0
UC  11.09   11.09
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH198
KO      0       0       0       0      22
HC      2
KKRNF180
KM     Local drainage gage 3 Sec 18/19 T161N R39W
KO      0       0       0       0      22
BA  11.52
LS      0      54       0
UC  18.81   18.81
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRCH180
KM     Sucker Creek Gage 1 to Outlet
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.125    0.05   0.125    9000  0.0023       0
*   rch180
RX      0      90     100     125     130     155     180     240
RY   1060    1050    1044    1041    1041    1044    1050    1060
KKRNF189
KM     Local drainage outlet Sucker Creek
KO      0       0       0       0      22
BA   0.69
LS      0      55       0
UC   7.44    4.98
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH189
KM     Sucker Creek Outflow
KO      0       0       0       0      22
HC      2
KKADH199
KO      0       0       0       0      22
HC      2
KKRSV199
KM temporary calibration reservoir
RS      1    STOR       0
*   rsv199stor
SV      0     800    1200    4800    6500    7000    7300    7400    7800    8000
*   rsv199flow
SQ      0     100     200     500    1000    1500    2500    3000    5000   15000
KKRCH199
KM     South Branch to North Branch
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.125   0.035   0.125    6000  0.0005       0
*   rch199
RX      0      90     100     106     146     152     290    1200
RY   1055    1040    1039    1033    1033    1039    1050    1055
KKADH200
KO      0       0       0       0      22
HC      2
KKRCH200
KM     Roseau River to USGS Gage near Malung
KO      0       0       0       0      22
```

```
RS     1    FLOW       0       0
RC 0.125   0.035   0.125    2400  0.0003       0
*  rch200
RX     0     400     435     443     493     501     600    1600
RY  1055    1045    1040    1034    1034    1040    1050    1055
KKRNF209
KM    Local drainage to USGS Gage near Malung  Gage 50
KO     0       0       0       0      22
BA  3.24
LS     0      55       0
UC  8.83    8.83
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH209
KO     0       0       0       0      22
HC     2
KKRCH209
KM    Roseau River gage 50 to CD 8
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125    1000  0.0003       0
*  rch200
RX     0     400     435     443     493     501     600    1600
RY  1055    1045    1040    1034    1034    1040    1050    1055
KKRNF211
KM    Local Drainage to Stafford area 1
KO     0       0       0       0      22
BA 11.25
LS     0      52       0
UC  16.8   11.25
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF212
KM    Local drainage to Stafford area 2
KO     0       0       0       0      22
BA  1.45
LS     0      53       0
UC  2.49    1.67
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKRNF213
KM    Local drainage to Stafford area 3
KO     0       0       0       0      22
BA   0.7
LS     0      47       0
UC  5.56    3.73
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH211
KO     0       0       0       0      22
HC     3
KKRCH211
KM    Roseau County Ditch 8 Stafford project to Outlet
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125    0.05   0.125   17120  0.0005       0
*  rch211
RX     0      10      16      31      37      52    1372    2640
RY1058.2    1058    1056    1051    1051    1056  1056.2  1056.5
KKRNF219
KM    Local Drainage Outlet RCD 8
KO     0       0       0       0      22
BA  6.26
LS     0      53       0
UC 17.92   17.92
```

```
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH220
KM     Roseau County ditch 8 outflow
KO      0        0        0        0       22
HC      2
KKADH221
KO      0        0        0        0       22
HC      2
KKRCH221
KM     Roseau River RCD 8 to Cow Creek
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125     8800   0.0003        0
*  rch221
RX      0     3600     3800     3812     3862     3874     4024     7624
RY   1055     1050     1035     1029     1029     1035     1050     1055
KKRNF229
KM     Local drainage Roseau River at Cow Creek
KO      0        0        0        0       22
BA   4.83
LS      0       53        0
UC 12.04    12.04
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH229
KM     Roseau River upstream Cow Creek
KO      0        0        0        0       22
HC      2
KKRNF248
KM     Local drainage Cow Creek Gage 44 Sec 31/32 T162N R39W
KO      0        0        0        0       22
BA   16.9
LS      0       55        0
UC 15.15    15.15
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH248
KM     Cow Creek Gage 44 to Outlet
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     4800   0.0023        0
*  rch248
RX      0      170      190      194      204      208      290      380
RY   1050     1045     1044     1040     1040     1044     1045     1050
KKRNF249
KM     Local drainage outlet Cow Creek
KO      0        0        0        0       22
BA   0.31
LS      0       58        0
UC   1.76     1.76
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH249
KM     Cow Creek Outflow
KO      0        0        0        0       22
HC      2
KKADH260
KO      0        0        0        0       22
HC      2
KKRCH260
KM     Roseau River Cow Creek to Center Street
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    11800   0.0003        0
```

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*  rch221
RX      0     3600     3800     3812     3862     3874     4024     7624
RY   1055     1050     1035     1029     1029     1035     1050     1055
KKRNF269
KM     Local drainage Roseau River at Center Street
KO      0        0        0        0       22
BA   5.07
LS      0       60        0
UC  10.04    10.04
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH269
KO      0        0        0        0       22
HC      2
KKRCH269
KM     Roseau River Center Street to Gage 15
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC  0.125    0.035    0.125    23500   0.0003        0
*  rch269
RX  11097    13712    20000    20035    20106    20131    20219    23721
RY1043.9   1038.4   1041.3   1024.7   1024.7   1036.8   1035.1   1043.6
KKRNF299
KM     Local drainage Roseau River Gage 15
KO      0        0        0        0       22
BA   5.51
LS      0       60        0
UC   9.18     9.18
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KKADH299
KO      0        0        0        0       22
HC      2
KKRNF319
KM     Local Drainage Hay Creek at County Road 2 Sec 1/12 T161N R37W
KO      0        0        0        0       22
BA  19.38
LS      0       57        0
UC  17.12    16.95
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH319
KM     Hay Creek County Road 2 to Branch CD 9
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC  0.125     0.05    0.125     7200   0.0017        0
*  rch319
RX      0     1130     1270     1282     1300     1312     1400     1650
RY   1110     1105     1095     1089     1089     1095     1105     1110
KKRNF335
KM     Upper Summer Road RCD 9 drainage
KO      0        0        0        0       22
BA  10.04
LS      0       51        0
UC  19.28    19.28
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKDVT335
KM     Split flow west to Summer Road
DTOUT335        0        0
*  din335
DI      0       50      100      200      300      500      750     1000
*  dout335
DQ      0       33       67      133      200      333      500      670
KKRCH335
```

```
KM    Branch of RCD 9 west to Hay Creek
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    8810  0.0005       0
*  rch335
RX      0     800    1700    1708    1712    1720    1722    1724
RY   1110    1107    1105    1101    1101    1105    1106    1107
KKADH336
KO      0       0       0       0      22
HC      2
KKRCH336
KM    Hay Creek branch RCD9 to Summer Road
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    7800  0.0017       0
*  rch336
RX      0    1130    1270    1282    1300    1312    1400    1650
RY   1105    1100    1090    1084    1084    1090    1100    1105
KKRNF339
KM    Local Drainage Hay Creek at Summer Road
KO      0       0       0       0      22
BA   10.5
LS      0      49       0
UC   17.2    17.2
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH339
KO      0       0       0       0      22
HC      2
KKRCH339
KM    Hay Creek Summer Road to Branch of RCD 9
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125    0.05   0.125    4400   0.001       0
*  rch339
RX      0     100    3550    3562    3580    3592    4000    4800
RY   1080    1078    1075    1069    1069    1075    1078    1080
KKRNF351
KM    Local drainage Upper Hwy 11
KO      0       0       0       0      22
BA   4.32
LS      0      55       0
UC 12.99   12.99
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKRTV335
KM    Split flow from Upper Summer Road North
DROUT335
KKRCH350   CNAME
RS      2    FLOW       0       0
RC 0.125    0.05   0.125   10560  0.0014       0
*  rch350
RX      0       2       4      12      16      24    1320    2640
RY   1107    1106    1105    1101    1101    1105  1105.5    1107
KKADH351
KO      0       0       0       0      22
HC      2
KKDVT351
KM Split flow to Roseau County Road 11
DTOUT351
*  din351
DI     0.    100.    200.    400.    600.    800.   1000.   2000.
*  dout351
DQ     0.     50.    100.    200.    300.    400.    500.   1000.
KKRCH351
```

```
KM    Branch RCD 9 to Hay Creek
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125     0.05    0.125    16600   0.0007        0
*  rch351
RX      0      750     1320     1328     1332     1340     1342     1344
RY   1090     1089     1088     1084     1084     1088     1090     1092
KKADH352
KO      0        0        0        0       22
HC      2
KKRCH352
KM    Hay Creek branch of RCD9 to Gage 12
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     7400   0.0014        0
*  rch352
RX      0      100     3550     3562     3580     3592     4000     4800
RY   1075     1073     1070     1064     1064     1070     1073     1075
KKRNF359
KM    Local drainage Hay Creek at Gage 12
KO      0        0        0        0       22
BA 12.44
LS      0       50        0
UC 13.97    14.39
* diamond
UA      0     0.09     0.34     0.64      0.9        1
KKADH359
KO      0        0        0        0       22
HC      2
KKRCH359
KM    Hay Creek Gage 12 to Branch RCD 9
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     9220   0.0009        0
*  rch359
RX      0      250      550      562      580      592      700     1000
RY   1070     1068     1065     1059     1059     1065     1068     1070
KKRTV351
KM    Upper Hwy 11 split flow
DROUT351
KKRCH352
RS      4     FLOW        0        0
RC 0.125     0.05    0.125    37920   0.0007        0
*  rch352
RX      0        2        4       12       16       24      500     1000
RY   1076     1075     1074     1070     1070     1074     1074     1075
KKADH360
KO      0        0        0        0       22
HC      2
KKRCH360
KM    Hay Creek Branch RCD9 to MN HWY 11
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     4980   0.0009        0
*  rch360
RX      0      250      550      562      580      592      700     1000
RY   1060     1058     1055     1049     1049     1055     1058     1060
KKRNF379
KM    Local Drainage MN Hwy 11
KO      0        0        0        0       22
BA 20.97
LS      0       54        0
UC  37.8     56.7
* fan
UA      0     0.05     0.15     0.35     0.65        1
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KKADH379
KO      0       0       0       0      22
HC      2
KKRCH379
KM    Hay Creek MN Hwy 11 to Hay Creek Proj Det 1
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125    5680  0.0004       0
*  rch379
RX      0    1000    2300    2312    2328    2340    4000    5000
RY  1060    1058    1058    1050    1050    1058    1058    1060
KKRNF381
KM    Hay Creek Proj Det 1
KO      0       0       0       0      22
BA  4.14
LS      0      54       0
UC 20.23   20.23
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH381
KO      0       0       0       0      22
HC      2
KKRCH381
KM    Hay Creek Det 1 to Roseau County Ditch 18
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC 0.125   0.035   0.125   10820  0.0004       0
*  rch381
RX      0    1000    2300    2312    2328    2340    4000    5000
RY  1055    1053    1053    1045    1045    1053    1053    1055
KKRNF385
KM    Norland sub RNF50 Roseau County Ditch 18  Sec 4/5 T162N R38W
KO      0       0       0       0      22
BA  8.39
LS      0      55       0
UC 29.83   59.66
*  rnf385
UA      0     0.1    0.24    0.46    0.65    0.75    0.83    0.89    0.94    0.98
UA      1
KKRCH385
KM    RCD 18 to Hay Creek
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08   17690   0.001       0
*  rch385
RX      0       5      10      45      53      57     100     250
RY1067.4  1067.4  1067.4 1056.14 1056.14  1064.7  1064.7  1064.7
KKRNF391
KM    Hay Creek Project Pool #1
KO      0       0       0       0      22
BA  2.21
LS      0      55       0
UC   3.6     3.6
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH391
KO      0       0       0       0      22
HC      2
KKRCH391   CNAME     391
KM    RCD 18 Pool#1 to NW Sec 2 T162N R39W
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08    5280  0.0003       0
*  rch391
RX      0       5      10      24      30      44    5000    5250
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RY  1053    1052    1049    1042    1042    1049  1049.5    1050
KKDVT391
KM Split flow RCD 18
DTOUT391
*  in391
DI    0.    300.    600.    900.   1200.   2100.
*  out391
DQ    0.    200.    400.    600.    800.   1400.
KKRCH392
KM    RCD 18 NW Sec 2 T162N R39W
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC  0.08    0.05    0.08    8300  0.0003       0
*  rch392
RX     0       5      10      24      30      44    5000    5250
RY  1052    1051    1048    1041    1041    1048  1048.5    1049
KKADH395
KO     0       0       0       0      22
HC     2
KKRCH395
KM    Hay Creek RCD 18 to Outlet
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   12900  0.0004       0
*  rch395
RX     0    1000    2300    2312    2328    2340    4000    5000
RY  1050    1048    1048    1040    1040    1048    1048    1050
KKRNF399
KM    Local drainage to Lower Hay Creek
KO     0       0       0       0      22
BA 19.76
LS     0      53       0
UC  24.8      31
* fan
UA     0    0.05    0.15    0.35    0.65       1
KKADH399
KM    Hay Creek at Outlet
KO     0       0       0       0      22
HC     2
KKADH400
KM Roseau River at Gage 15 Sec 6/31 T162-163N R39W County Road 28
KO     0       0       0       0      22
HC    2.
KKRSV400
KM Storage behind CR 28
KO     0       0       0       0      22
RS     1    FLOW       0
*  rsv400stor
SV     0     147     247     847    2587    4517    7282   10872   15272   20471
*  rsv400flow
SQ     0     720     800    2190    4110    5200    6120    8450   10000   11690
KKRTV391
KM    Overflow RCD 18
DROUT391
KKRC391b
RS     1    FLOW       0       0
RC  0.08    0.05    0.08   17000  0.0006       0
*  rc391b
RX     0       2       4      14      18      28    1300    2600
RY  1057    1056    1055    1050    1050    1055  1055.5    1057
KKADH401
KM    Roseau River at Sout side Sec 31 T163N R39W at lateral JD61
KO     0       0       0       0      22
HC     2
KKRC391m
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KM    Roseau River Gage 15 to Lat 3 Judicial 61
KO      0       0       0       0      22
RS      1    STOR       0       0
*  stor391m
SV      0      90     132     228     606    2187    2916    3579    4242    5460
*  flow391m
SQ      0     500    1000    2000    3000    5000    6000    7000    8000   10000
KKRNF401
KM    Norland sub RNF20 Sec 28/29 T163N R37W
KO      0       0       0       0      22
BA   2.85
LS      0      57       0
UC   6.27    9.41
*  rnf401
UA      0       0    0.01    0.03    0.09    0.19    0.29    0.51    0.78    0.95
UA      1
KKRCH401
KM    Lat 3 JD61
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08    5120   0.006       0
*  rch401
RX      0       5      10      19      27      36     143     243
RY1079.1    1079    1078    1075    1075    1078    1079  1079.1
KKRNF402
KM    Norland Sub RNF30
KO      0       0       0       0      22
BA   6.43
LS      0      54       0
UC  39.75    79.5
*  rnf402
UA      0    0.19    0.33    0.56    0.79    0.87    0.92    0.93    0.95    0.99
UA      1
KKADH402
KO      0       0       0       0      22
HC      2
KKDVT402
KM 50-50 split west and north
DTOUT402
*  in402
DI     0.      10.     20.     30.     40.     50.    100.    200.    500.   1000.
*  out402
DQ     0.       5.     10.     15.     20.     25.     50.    100.    250.    500.
KKRCH402
KM    Lat 3 JD61
KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08   10320   0.006       0
*  rch402
RX      0       5      10      22      30      42      47     252
RY1075.1    1075    1074    1070    1070    1074    1075  1075.1
KKRNF403
KM    Norland Sub RNF40
KO      0       0       0       0      22
BA   5.66
LS      0      49       0
UC  13.51   13.51
*  rnf40
UA      0     0.1    0.29     0.5    0.62    0.74     0.8    0.86    0.91    0.95
UA      1
KKADH403
KO      0       0       0       0      22
HC      2
KKRCH403
KM    Lat 3 JD 61
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KO      0       0       0       0      22
RS      1    FLOW       0       0
RC  0.08    0.05    0.08    9650   0.006       0
*  rch403
RX      0       5      10      22      30      42      47     252
RY1070.1    1070    1069    1065    1065    1069    1070  1070.1
KKRNF405
KM    Norland sub RNF60
KO      0       0       0       0      22
BA  7.08
LS      0      55       0
UC 11.04   11.04
*  rnf405
UA      0    0.08    0.18    0.31    0.51    0.65    0.82     0.9    0.97    0.99
UA      1
KKADH405
KM    Sec 21/22 T163N R38W
KO      0       0       0       0      22
HC      2
KKRNF406
KM    Norland sub RNF65
KO      0       0       0       0      22
BA  1.71
LS      0      46       0
UC      5    5.85
*  rnf406
UA      0    0.13    0.25    0.34    0.45    0.57     0.7     0.8    0.89    0.97
UA      1
KKADH406
KM    Sec 21/22 T163N R38W
KO      0       0       0       0      22
HC      2
KKRNF408
KM    Norland Pool area RNF70
KO      0       0       0       0      22
BA  7.65
LS      0      48       0
UC 12.55   18.83
*  rnf408
UA      0    0.02    0.08    0.15    0.26    0.41    0.61    0.75    0.87    0.93
UA      1
KKADH408
KO      0       0       0       0      22
HC      2
KKDVT408
KM Split Norland flows into BR 5 Lat 3 and Lat 3 flows
DTOUT410
*  in410
DI    0.     35.     99.    239.    443.    696.   1065.   1515.   2032.
*  out410
DQ    0.     11.     33.     80.    148.    232.    355.    505.    677.
KKRCH420
KM    Lat 3 JD 61
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125    0.05   0.125   24200  0.0006       0
*  rch420
RX      0       6       8      18      24      34    1320    1325
RY  1054    1051    1050    1045    1045    1050    1050    1054
KKADH421
KO      0       0       0       0      22
HC      2
KKRCH421
KM    Roseau River Lat 3 JD 61 to Hwy 310
KO      0       0       0       0      22
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RS      1    STOR        0        0
*  stor421
SV      0     312      459      792     2106     7611    10140    12450    14757    18993
*  flow421
SQ      0     561     1000     2000     3000     5000     6000     7000     8000    10000
KKRTV430
KM    Br 5 Lat 3 JD61
DROUT410
KKRCH430
RS      4    FLOW        0        0
RC 0.125    0.05    0.125    44000   0.0004        0
*  out410
RX      0        6        8       18       24       34     1320     1325
RY   1054     1051     1050     1045     1045     1050     1050     1054
KKADH430
KO      0        0        0        0       22
HC      2
KKRNF499
KM    Local drainage Roseau River at MN Hwy 310
KO      0        0        0        0       22
BA 19.26
LS      0       49        0
UC 18.59    32.35
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH499
KM    Roseau River at MN Hwy 310
KO      0        0        0        0       22
HC      2
KKRNF520
KM    East Fork of Sprague Creek
KO      0        0        0        0       22
BA 22.42
LS      0       51        0
UC  43.2     64.8
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRNF530
KM    West Fork of Sprague Creek
KO      0        0        0        0       22
BA 20.42
LS      0       45        0
UC 48.32    72.48
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH530
KO      0        0        0        0       22
HC      2
KKRCH530
KM    Sprague Creek forks to Vasser Road
KO      0        0        0        0       22
RS      6    FLOW        0        0
RC 0.125     0.04    0.125    40765   0.0006        0
*  rch530
RX      0       10      510      516      534      540     1040     1050
RY   1080     1075     1073     1067     1067     1073     1075     1080
KKRNF540
KM    Local drainage to Sprague Creek at Vassar Road
KO      0        0        0        0       22
BA 47.64
LS      0       51        0
UC 43.35    65.03
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH540
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KO      0       0       0       0       22
HC      2
KKRCH540
KM    Sprague Creek Vassar Road to Mud Creek
KO      0       0       0       0       22
RS      5    FLOW       0       0
RC 0.125    0.04   0.125   56058  0.0005       0
*  rch540
RX      0      10     510     516     534     540    1040    1050
RY   1075    1070    1068    1062    1062    1068    1070    1075
KKRNF545
KM    Local drainage Sprague Creek at Sprague Manitoba
KO      0       0       0       0       22
BA 21.93
LS      0      57       0
UC  35.7   53.55
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH545
KM    Sprague Creek at Sprague
KO      0       0       0       0       22
HC      2
KKRNF510
KM    Local Drainage to Mud Creek
KO      0       0       0       0       22
BA 32.18
LS      0      59       0
UC 71.13   106.7
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH546
KO      0       0       0       0       22
HC      2
KKRCH546
KM    Sprague Creek Sprague to USGS Gage
KO      0       0       0       0       22
RS      2    FLOW       0       0
RC 0.125    0.04   0.125   17973  0.0009       0
*  rch546
RX      0      10     510     516     534     540    1040    1050
RY   1065   10602    1057    1051    1051    1057    1060    1065
KKRNF550
KM    Local drainage Sprague Creek at USGS Gage
KO      0       0       0       0       22
BA 39.01
LS      0      55       0
UC 52.83    35.4
* fan
UA      0    0.05    0.15    0.35    0.65       1
KKADH550
KM Sprague Creek at USGS gaging station
KO      0       0       0       0       22
HC      2
KKRCH550
KM    Sprague Creek USGS Gage to Lat 2 JD 61
KO      0       0       0       0       22
RS      3    FLOW       0       0
RC 0.125    0.04   0.125   32800  0.0006       0
*  rch550
RX      0      50    1850    1856    1874    1880    2980    3030
RY   1050    1047    1045    1039    1039    1045    1047    1050
KKRNF570
KM    Local Drainage to Upper Lat 2 JD 61
KO      0       0       0       0       22
BA 54.33
```

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LS      0       60        0
UC 39.24    58.86
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRTV402
KM    Split flow out of RNF402
DROUT402
KKRCH571
RS      1     FLOW        0        0
RC  0.08     0.05     0.08    10420   0.0006        0
*  rch571
RX      0        2        4       10       24       30     1300     2600
RY   1081     1080     1079     1076     1076     1079   1079.5     1080
KKADH574
KO      0        0        0        0       22
HC      2
KKRCH574
KM    Lat 2 JD 61
KO      0        0        0        0       22
RS      4     FLOW        0        0
RC 0.125     0.05    0.125    31460   0.0005        0
*  rch574
RX      0        1        5        9       17       21     2621     2655
RY   1047     1046     1042     1038     1038     1042     1043     1045
KKADH575
KO      0        0        0        0       22
HC      2
KKRCH575
KM    Sprague Creek Br2 JD 61 to Outlet
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.04    0.125     9000   0.0005        0
*  rch575
RX      0       15     1515     1521     1541     1547     2547     2555
RY   1036     1033     1032     1026     1026     1032     1033     1035
KKRNF580
KM    Local drainage to Sprague Creek at Outlet
KO      0        0        0        0       22
BA 47.32
LS      0       62        0
UC     29     43.5
* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH580
KM    Sprague Creek at Outlet
KO      0        0        0        0       22
HC      2
KKADH456
KM Combined flows Roseau River and Sprague Creek
KO      0        0        0        0       22
HC      2
KKRCH456
KM    Roseau Rive Sprague Creek to Roseau Lake Bed
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125    0.035    0.125    27200   0.0002        0
*  rch456
RX      0     1320     2640     2665     2718     2743     4063     5390
RY   1035 1034.25     1034   1021.5   1021.5     1034 1034.25     1035
KKRNF610
KM    South Roseau Lake Bottom
KO      0        0        0        0       22
BA 40.91
LS      0       53        0
UC 10.48     7.02
```

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* rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKRNF620
KM     North Roseau Lake Bottom
KO      0         0        0        0       22
BA  46.2
LS      0       55        0
UC 40.11    40.11
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH620
KM     Roseau River at Lake Bed
KO      0         0        0        0       22
HC      3
KKRNF700
KM     Local Drainage West Pine Creek
KO      0         0        0        0       22
BA 33.76
LS      0       43        0
UC 56.23    37.67
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH700
KM     West Pine Creek Manitoba Hwy 12 to East Pine Creek
KO      0         0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     1672   0.0014        0
*   rch700
RX      0      750     1500     1510     1518     1528     2278     3000
RY   1100     1095     1090     1086     1086     1090     1091     1095
KKRNF710
KM     Local drainage East Pine Creek
KO      0         0        0        0       22
BA  9.55
LS      0       41        0
UC 20.36    13.63
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRCH710
KM     East Pine Creek Manitoba Hwy 12 to West Pine Creek
KO      0         0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     2048   0.0014        0
*   rch710
RX      0      750     1500     1510     1516     1526     2276     3000
RY   1095     1091     1090     1086     1086     1090     1095     1100
KKADH710
KM     Pine Creek near Hwy 12
KO      0         0        0        0       22
HC      2
KKRCH711
KM East and West Pine Creek to Diversion
KO      0         0        0        0       22
RS     1.     FLOW        0
RC 0.125     0.05    0.125    19288   0.0014
*   rch711
RX      0      750     3000     3010     3016     3026     5250     6000
RY   1095     1090     1085     1081     1081     1085     1090     1095
KKRNF720
KM     Local drainage Pine Creek at Diversion
KO      0         0        0        0       22
BA 16.68
LS      0       49        0
UC  7.58     5.08
* fan
```

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UA      0     0.05     0.15     0.35     0.65        1
KKADH720
KM Pine Creek Upstream of Diversion
KO      0        0        0        0       22
HC    2.
KKDVT720
KM Pine Creek Diversion
DTOUT720
*  in720
DI     0.     220.     300.     500.    1000.    1250.    1500.    2000.
*  out720
DQ     0.     220.     273.     407.     740.     850.     850.     850.
KKRCH720
KM     Pine Creek Diversion to Roseau County Road 118
KO      0        0        0        0       22
RS      3     FLOW        0        0
RC 0.125     0.04    0.125    37815    0.001        0
*  rch720
RX      0      600     1180     1184     1192     1196     1700     2410
RY   1050     1047     1045    10417     1041     1045     1047     1050
KKRNF790
KM     Local Drainage at RCR 118
KO      0        0        0        0       22
BA 20.29
LS      0       56        0
UC 17.76    17.76
*  rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH790
KM     Pine Creek at Lake Bottom
KO      0        0        0        0       22
HC      2
KKADH699
KO      0        0        0        0       22
HC      2
KKRSV699
KM     Roseau Lake Bottom
KO      0        0        0        0       22
RS      1     FLOW        0        0
*  stor699
SV      0      500     1100     3000     5580    12970    17860    28000    40000    52260
SV  60590    74010    84505   144375   179500   203000
*  flow699
SQ      0      250      732      954     1136     1372     1638     1924     2222     2574
SQ   3084     3868     4494     5200     7500    10000
*  elev699
SE1017.1   1024.8     1026     1027     1028     1029     1030     1031     1032     1033
SE   1034     1035   1035.5     1036     1037     1038
KKRCH699
KM     Roseau River Ross to Lins Bridge
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125    0.035    0.125    24390   0.0005        0
*  rch699
RX      0        9     3200     3232     3299     3331     5271     5280
RY   1035     1032     1030     1014     1014     1030     1032     1035
KKRNF900
KM     Local drainage at Lins Bridge
KO      0        0        0        0       22
BA 41.99
LS      0       54        0
UC 14.73     9.87
*  rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH900
```

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KO      0       0       0       0      22
HC      2
KKRCH900
KM    Roseau River Lins Bridge to Big Swamp
KO      0       0       0       0      22
RS      2    FLOW       0       0
RC 0.125   0.035   0.125   24390  0.0004       0
*  rch900
RX      0      25      35      67     134     166    2806    5280
RY   1035    1030    1028    1012    1012    1028    1030    1032
KKRNF920
KM    Local drainage upstream of Big Swamp
KO      0       0       0       0      22
BA 24.09
LS      0      59       0
UC 32.83   32.83
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKADH920
KO      0       0       0       0      22
HC      2
KKRCH920
KM    Roseau River to Roseau River Wildlife Management Pool 2 Outlet
KO      0       0       0       0      22
RS     52    FLOW       0       0
RC 0.125   0.035   0.125   13000  0.0004       0
*  rch920
RX      0    2640    5280    5296    5363    5380    8020   10659
RY   1025  1024.5    1024    1018    1018    1024  1024.5    1025
KKRNF810 RRWMA Pool 1
KM    Local Drainage to RRWMA Pool 1
KO      0       0       0       0      22
BA 24.88
LS      0      58       0
UC   13.3    13.3
* rectangle
UA      0     0.2     0.4     0.6     0.8       1
KKRTV720
KM    Pine Creek Diversion
DROUT720
KKRC720a
RS      3    FLOW       0       0
RC  0.05    0.05    0.05   41517  0.0001       0
*  rc720a
RX      0      10      28      42      52      66      84      94
RY   1068    1063    1063    1056    1056    1063    1063    1068
KKADH810
KO      0       0       0       0      22
HC      2
KKRSV810
KM    RRWMA Pool 1
KO      0       0       0       0      22
RS      1    STOR    2415       0
*  stor810
SV   2415    2477    3968    4899    4215    4575    5115    5475    6415    6735
*  flow810
SQ      0     8.4      33     235     460     820    1390    1960    3035    4735
*  elev810
SE   1035  1035.2  1035.5  1035.8    1036  1036.2  1036.5  1036.7    1037  1037.4
KKRNF820
KM    Local drainage RRWMA Pool 2
KO      0       0       0       0      22
BA 89.71
LS      0      58       0
UC     51    76.5
```

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* fan
UA      0     0.05     0.15     0.35     0.65        1
KKADH820
KO      0        0        0        0       22
HC      2
KKRSV820
KM     RRWMA Pool 2
KO      0        0        0        0       22
RS      1     STOR     4450        0
*  stor820
SV   4450     5400     6800     8400     9500    10800    12800    14300    16540    19550
*  flow810
SQ      0      8.4       33      235      460      820     1390     1960     3035     4735
*  elev820
SE   1029   1029.2   1029.5   1029.8     1030   1030.2   1030.5   1030.7     1031   1031.4
KKDVT820
KM Main outlet Roseau River, Emergency Spillway and Secondary Outlet
DTOUT820
*  in820
DI     0.      8.4      33.     235.     460.     820.    1390.    1960.    3035.    4735.
*  out820
DQ     0.       0.       0.     170.     370.     700.    1225.    1645.    2345.    3325.
KKRCH821
KM     Roseau County Ditch 17
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125     3900   0.0001        0
*  rch821
RX      0     1050     2100     2108     2116     2124     2128     2134
RY   1025     1022     1020     1016     1016     1020     1022     1025
KKRCH822
KM     Old Roseau River Channel
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125     8800   0.0001        0
* rch822
RX      0      500     1400     1408     1548     1556     2500     4000
RY   1024     1022     1020     1016     1016     1020     1022     1024
KKADH930
KO      0        0        0        0       22
HC      2
KKRCH930
KM     Roseau River Pool 2 outlet to Pool 3 outlet
KO      0        0        0        0       22
RS      2     FLOW        0        0
RC 0.125    0.035    0.125    15200   0.0004        0
*  rch930
RX      0     2640     5280     5296     5363     5380     8020    10659
RY   1020   1019.5     1019     1013     1013     1019   1019.5     1020
KKRNF830
KM     Local drainage RRWMA Pool 3
KO      0        0        0        0       22
BA 23.73
LS      0       52        0
UC   12.5     12.5
* fan
UA      0     0.05     0.15     0.35     0.65        1
KKRTV820
KM     Pool 2 outflow to Pool3
DROUT820
KKADH830
KO      0        0        0        0       22
HC      2
KKRSV830
KM     RRWMA Pool 3
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```
KO      0        0        0        0       22
RS      1     STOR     2700        0
*  stor830
SV   2700     3400     4500     5800     6750     7750     9700    12900    16650
*  flow830
SQ      0      8.4       33      185      355      620     1040     1925     2980
*  elev830
SE   1024   1024.2   1024.5   1024.8     1025   1025.2   1025.5     1026   1026.5
KKRCH831
KM     Outlet Channel Pool3
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     2920   0.0001        0
*  rch831
RX      0      700     1400     1410     1420     1430     2100     3000
RY   1023     1022     1021     1016     1016     1021     1022     1023
KKRCH832
KM     Old Roseau River Channel
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125     0.05    0.125     1150   0.0001        0
*  rch832
RX      0      700     1400     1412     1512     1514     2100     3000
RY   1023     1022     1021     1015     1015     1021     1022     1023
KKADH940
KO      0        0        0        0       22
HC      2
KKRCH940
KM     Roseau River pool 3 to end of Big Swamp
KO      0        0        0        0       22
RS      1     FLOW        0        0
RC 0.125    0.035    0.125    34000   0.0004        0
*  rch940
RX      0     2640     5280     5296     5363     5380     8020    10659
RY   1019   1018.5     1018     1012     1012     1018   1018.5     1019
KKRNF950
KM     Local drainage Big Swamp
KO      0        0        0        0       22
BA 88.82
LS      0       63        0
UC 32.48    48.72
*  rectangle
UA      0      0.2      0.4      0.6      0.8        1
KKADH950
KO      0        0        0        0       22
HC      2
KKRSV950
KM      Big Swamp Storage
KO      0        0        0        0       22
RS      1     STOR        0        0
*  stor950
SV      0     2000     6000    13000    21000    29000    37000    45000    53000    69000
*  flow950
SQ      0      700     1300     1900     2300     2600     2900     3200     3500     4100
KKDVT950
KM Flow transfer to Two Rivers
DTOUT920
*  in920
DI     0.    2000.    3513.    3699.    4403.
*  out920
DQ     0.       0.     533.     619.    1083.
KKRCH950
KM     Roseau River Big Swamp to USGS Gaging Station
KO      0        0        0        0       22
RS      3     FLOW        0        0
```

```
RC 0.125   0.035   0.125   32900  0.0002       0
*  rch950
RX     0    1600    2200    2220    2275    2295    2900    3250
RY  1020    1018    1015    1005    1005    1015    1018    1020
KKRNF960
KM    Local drainage to USGS Gage near Caribou
KO     0       0       0       0      22
BA 24.04
LS     0      53       0
UC 24.04    33.8
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKADH960
KO     0       0       0       0      22
HC     2
KKRCH960
KM    Roseau River Caribou to International Border
KO     0       0       0       0      22
RS     1    FLOW       0       0
RC 0.125   0.035   0.125   12200   .0003       0
*  rch960
RX     0    1600    2200    2220    2275    2295    2900    3250
RY  1015    1013    1010    1000    1000    1010    1013    1015
KKRNF999
KM    Local Drainage Roseau River at Border
KO     0       0       0       0      22
BA  9.56
LS     0      52       0
UC 13.78   13.78
* rectangle
UA     0     0.2     0.4     0.6     0.8       1
KKADH999
KM    Roseau River at International Border
KO     0       0       0       0      22
HC     2
KKRTV920
KM Diverted flow to Two Rivers
DROUT920
ZZ
```